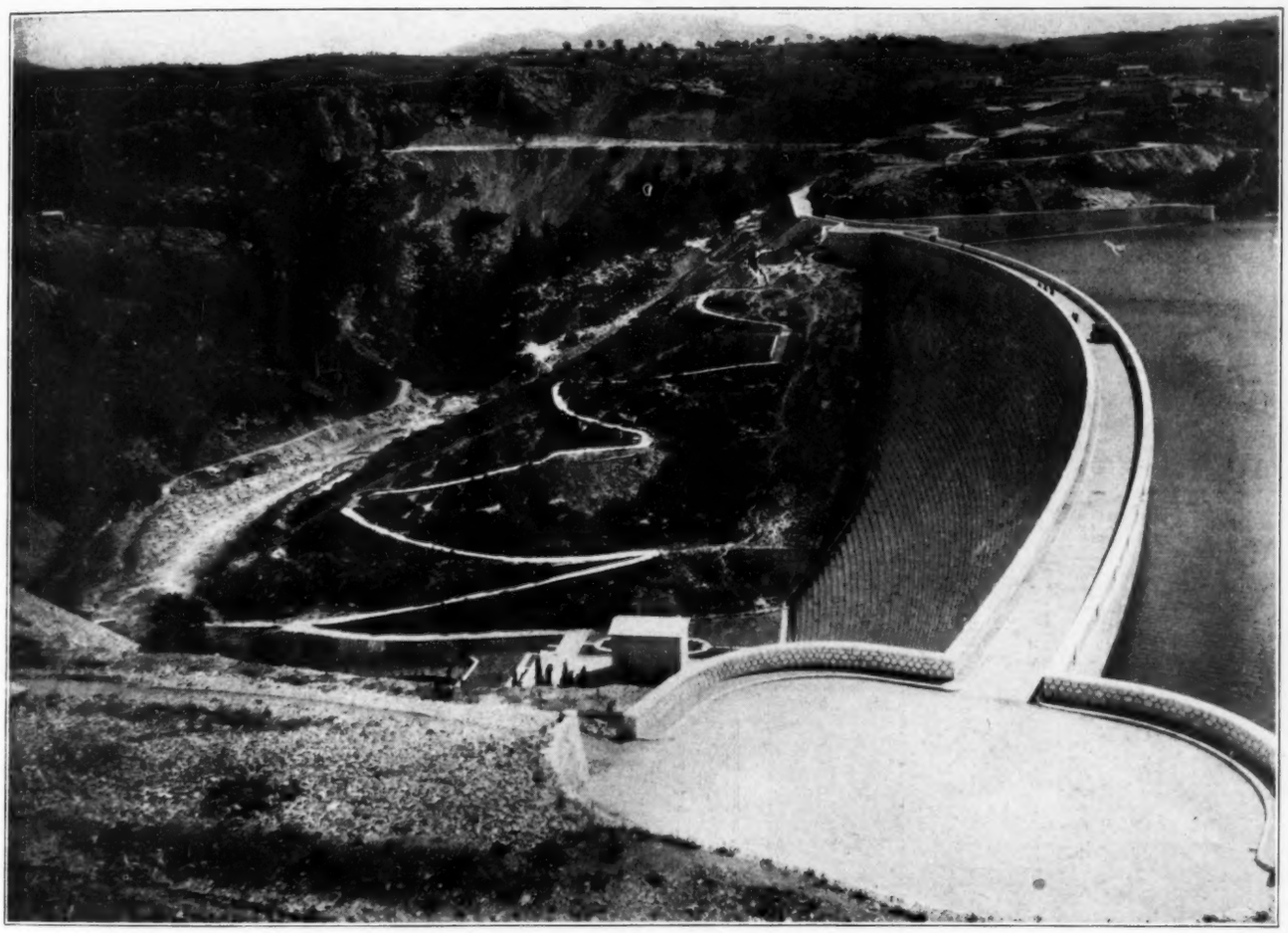
WATER WORKS AND SEWERAGE

April, 1933 — L. H. Enslow, Editor — Vol. LXXX. No.4



The Marathon Dam, Storing 11,000,000,000 Gals. on the New Water SupplySystem of Athens, Greece

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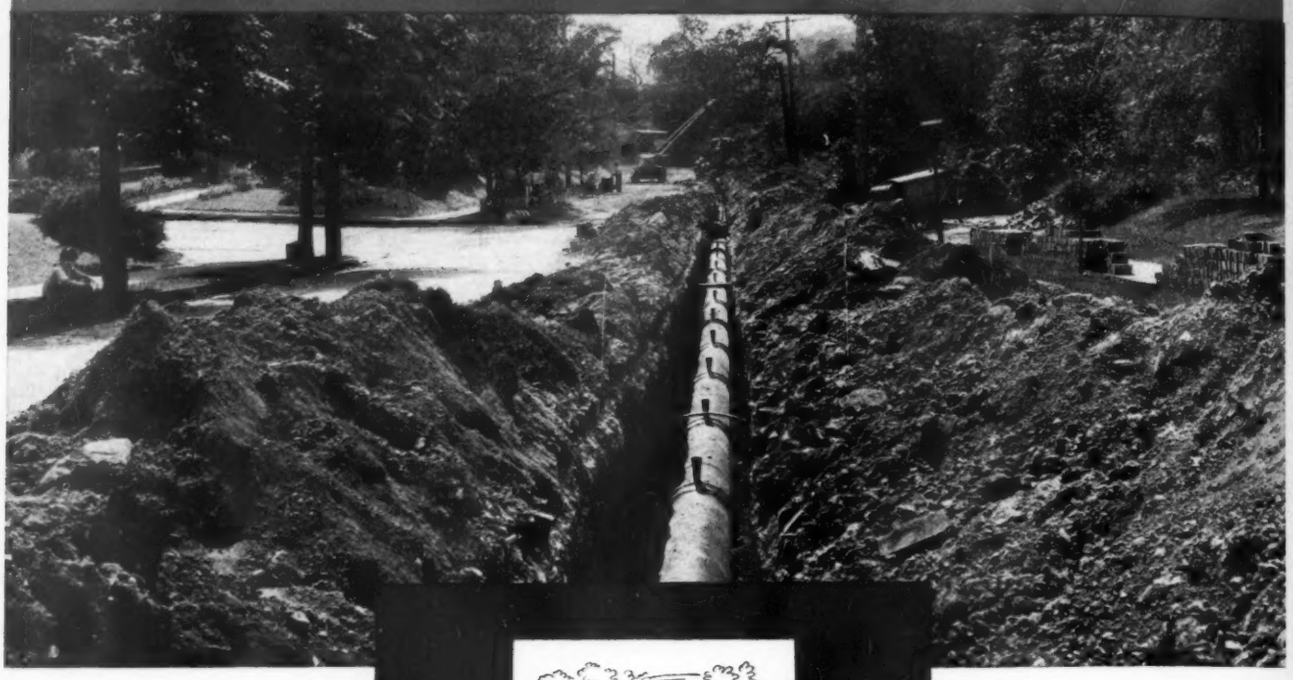
Gives New Pipe Lines a
CLEAN BILL of HEALTH



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source of danger to the health
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problem by a method that is nov
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sections as they are laid, and the
the line is still cut off from the
the system, it is slowly filled wit
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water is flushed off through a hy
the further end of the line.

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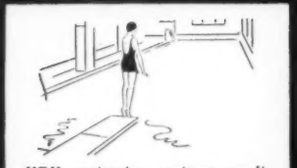

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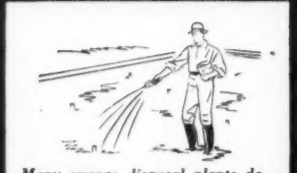

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WATER WORKS & SEWERAGE

L. H. ENSLOW, Editor

LEADING ARTICLES To Appear in the Next and Subsequent Issues:

Malcolm Pirnie, Consulting Engineer of New York City and President-elect of the A. W. W. A., in a near future issue will discuss the subject of "Water Supply in Relation to City and Regional Planning."

Darwin W. Townsend, Principal Assistant Engineer of the Sewerage Commission of Milwaukee, is preparing two articles on "Screenings and Grit Incineration." A description of the new screenings incineration plant at Milwaukee will be presented. Experiences in operation and operating cost data will be revealed in a second article.

Roger W. Esty, Superintendent of Water Works at Danvers, Mass., will recount interesting and unusual "Experiences in Locating Pipe Lines" with the wireless pipe locator.

Harry F. Ferguson, Chief Engineer of the Illinois State Department of Health, will tell of the revamping of an overloaded sewage treatment works wherein chlorination is being successfully used for relieving bad stream conditions in lieu of funds for the construction of additional new works at this time.

P. S. Wilson, Consultant in Water Works Operation and formerly with the Community Water Service Company, will describe practical methods of making flow and pressure tests at fire hydrants and the value of securing such data.

A. C. Orthmann, Consulting Chemical Engineer of Milwaukee, presents his first article on the subject of "Water Supply for Leather Tanning" in this issue. His next article will deal with the "Treatment and Requirements of Water in Tanning."

Robert B. Morse, Chief Engineer of the Washington Suburban Sanitary Districts, will tell of the use of light weight cast iron pipe in sewer construction. Permanency of structure, simplified construction, increased carrying capacity and other miscellaneous advantages are cited to justify the selection of cast iron pipe for the Washington suburban sewerage projects.

Carl Leipold, Superintendent of Filtration at Winnetka, Ill., will continue with his series of short articles of interest to operators of filtration plants.

R. F. Goudey, Sanitary Engineer, Los Angeles, Calif., will describe a novel method of concentrating activated sludge in final clarifiers to reduce the volume in subsequent handling and to prevent sludge "bulking" difficulties.

Sheppard T. Powell, Consulting Chemical Engineer, of Baltimore, Md., will write on "Water Supply Practice in Oil Refining Operations."

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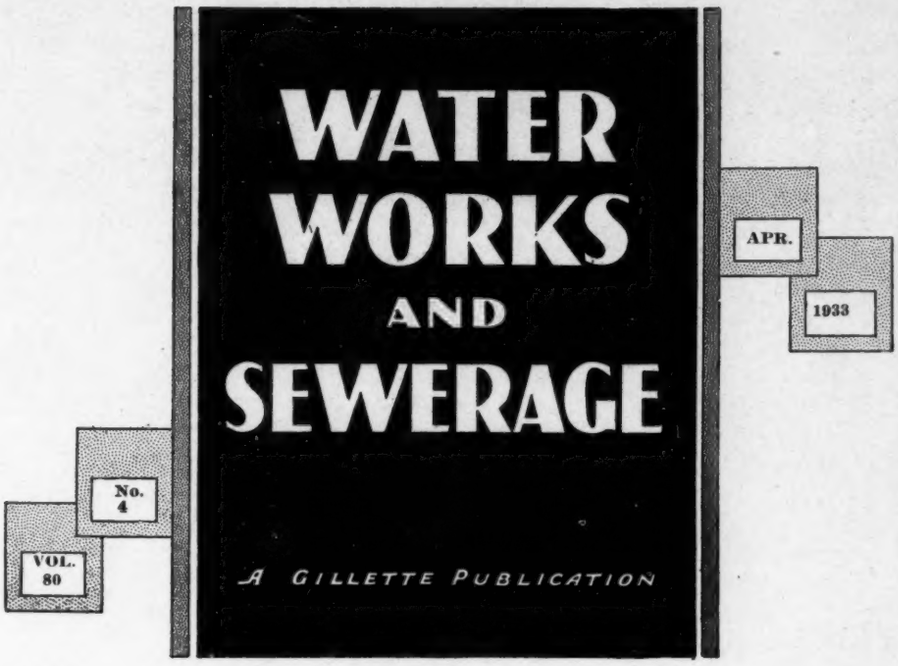


OPERATING CONDITIONS AT THE ATHENS, GREECE, WATER PURIFICATION PLANT

By LOUIS A. GEUPEL

Water Purification Engineer, Societe Des Eaux, Athens, Greece.

The author of this article writes to say: "This sketchy description of the new filtration plant at Athens, with a few comments on operating results, is being written for WATER WORKS AND SEWERAGE with the thought that the spread of American practice and equipment to foreign water works fields would interest American water works men."

The products of twelve different nations were used in the plant but by far American equipment predominated.

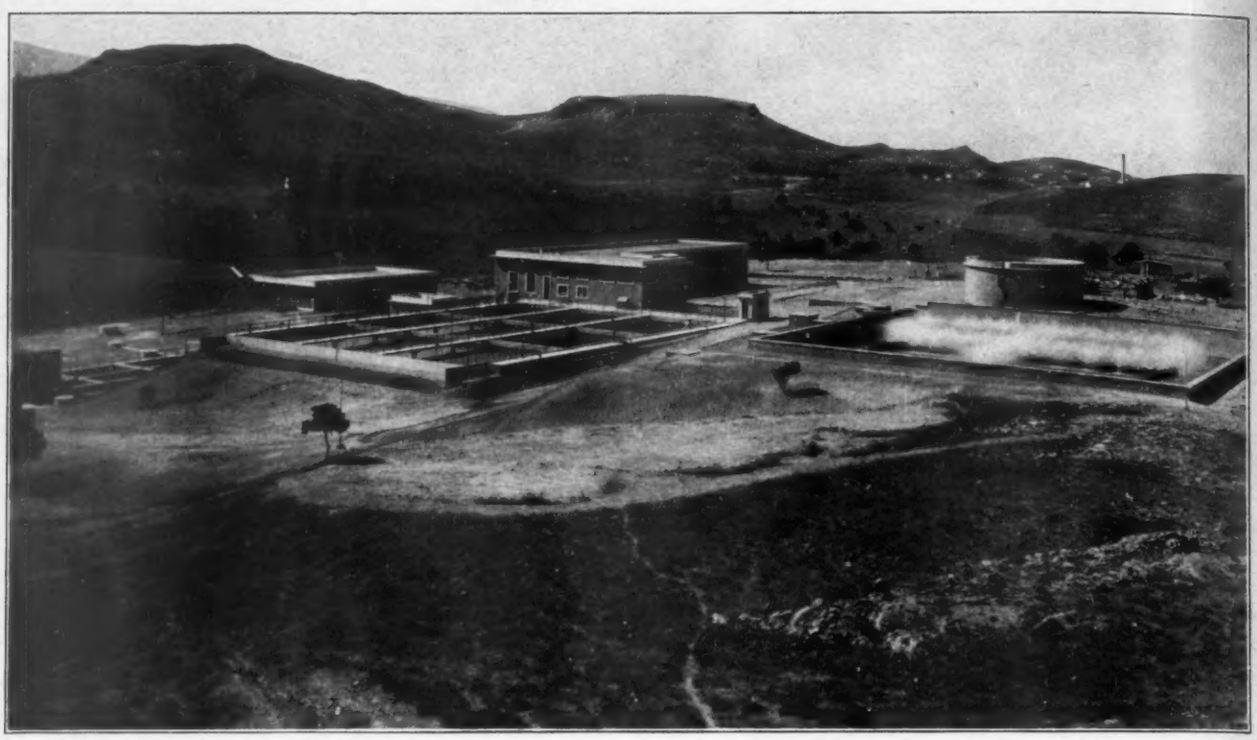
Mr. Geupel, formerly Chief Engineer of the Ulen Company's organization in Poland, joined the Athens organization of this company in 1930 as Engineer of Design and later as Construction Superintendent during the construction of the filtration plant. Upon completion of the plant he became Superintendent of Filtration for the operating company, the Societe Des Eaux, and has only recently returned to America.—EDITOR.

THE water supply for Athens, Piraeus, and Environs is obtained from a number of sources, namely, Old Hadrian Aqueduct which receives its supply from the galleries located southerly from Mt. Parnas in amounts of about 6,000 cubic meters (1,600,000 gallons) per day in the summer; the new impounded Lake of Marathon with its normal capacity of 42,000,000 cubic meters (11,000,000,000 U. S. gallons); the percolation water from the limestone strata into 13.48 kilometers (8.5 miles) of tunnel which yields approximately 5,000 cubic meters (1,325,000 U. S. gallons) per day; and the Kokinara driven wells in the limestone with artesian flow into the tunnels amounting to approximately 4,300 cubic meters (1,400,000 U. S. Gallons) per day.

The cities of Athens, Piraeus and Environs are using about 35,000 cubic meters (9,300,000 U. S. gallons) of water per day which, with the system 50 per cent connected to the consumers, due to lack of funds, shows about 20 liters (5.5 gallons) per capita per day consumed.

The Hadrian Aqueduct, yielding 1,600,000 U. S. gallons per day during the summer months, is a part of the old water system of Athens built about 115 to 130 A. D. under the regimes of Emperors Hadrian and Antonius Pius. Twenty-five kilometers (15.5 miles) of the aqueduct and galleries extending from the bases of Mt. Parnas and Pentelikon to the city of Athens have been repaired and the aqueduct still delivers from 1,600,000 U. S. gallons per day of clear subterranean limestone water in the summer, to 5,300,000 U. S. gallons of slightly turbid water during the wet season. The depth of the Hadrian Aqueduct varies from 10 meters (roughly 33 ft.) to 40 meters (131 ft.) below ground surface, and the shafts for the old construction are 30 to 40 meters (100 to 131 ft.) apart. These shafts are round and of limestone masonry construction. These are now capped over with concrete domes, but were originally covered over with marble slabs. The Hadrian Aqueduct delivers water to the new and old Hadrian reservoirs located on the slopes of Mt. Lycabetus from where it travels by gravity to the city water system.

As in most clear limestone waters pollution is found,



General View of New 18 MGD Filtration Plant, Athens, Greece. Largely an American Equipped Plant. Wash Water Tank in Rear of Sprayco Equipped Aerator. Link-Belt Wash Water Recovery Plant on Extreme Right Down Hill. Filtered Water Reservoir (covered) Just Beyond

in all untreated samples. When used, the Hadrian water is ammoniated and chlorinated before entering the storage reservoirs. The storage reservoirs permit at least a six hours' retention period which we know is ample time for any delayed germicidal action by the chloramines. All samples of the treated water have met the requirements of the U. S. Public Health Service.

Operating Procedure

The general operating procedure during the year is to use the Hadrian water only when it is needed and then only when this supply is clear and wholesome. During the year 1932 the Hadrian water was introduced into the system on July 16th. The specific date was determined by the lowering of the level of Lake Marathon to 50 centimeters (20 inches) below the crest of the overflow of the dam. One must understand the climate conditions and also the amount of rain fall at Athens and vicinity to appreciate why no risks are taken in the matter of depleting the impounded supply. From May to November each year, very little if any rainfall occurs, which means that the water stored in Lake Marathon even with its 8 to 10 millimeter (0.35 to 0.4 inch) evaporation loss per day, must be conserved in anticipation of the possibility of a dry winter without the average rainfall and run-off. The above explanation clearly shows why the 6,000 cubic meters per day flow from Hadrian is used during the dry season. In winter when the Hadrian galleries yield 15,000 cubic meters (4,000,000 U. S. gallons) and the water is slightly turbid, the lake at Marathon is also generally overflowing and all of the water supplied consumers passes through the new 18 million gallon filtration plant.

All water from Lake Marathon, the weeper tunnel, and the Kokinara wells comes by gravity to the filtration plant thence into a 42,000 cubic meter (11,000,000 U. S. gallon) covered clear water reservoir from which it flows by gravity to the city.

The turbidity of the raw water is usually very low, ranging from 5 to 10 parts per million during 8 months of the year and from 20 to, perhaps, a rare 100 parts per million after heavy down pours during the other four months of the year. One can see by virtue of the large clear water reservoir of 42,000 cubic meters (11,000,000 U. S. gallons) capacity, with good circulation and a consumption of 6 to 8 million gallons per day only, that the filtration plant was not considered an economical unit of construction and the Government of Greece was so informed. The Government Control together with the Sanitary Commission wished to have a guarantee of clear and safe water at all times and realizing that the entire purification plant cost amounted to but 3 per cent of the total construction work, ordered the building of the filtration plant, including aeration, sedimentation, filtration, chloramine sterilization, and a wash water recovery plant. The filtration plant completed and placed in operation on Jan. 10, 1932, has operated continuously without any shut down.

The Filtration Plant

The following is a description of component parts of the filter plant.

Aeration

The aerator is located in a separate open basin on the crest of a rock hill adjacent to the filters. The water is sprayed through 100 Spraco center-jet bronze nozzles having 1⅛ inch orifices. The nozzles require 5 meters (7 lbs. per square inch) head, which gives a full cone spray. These nozzles are operating excellently and the full capacity of the aerator is about 65,000 meters (17,000,000 U. S. gallons) per day.

Chemical Feed, Mixing and Prechlorination

From the aerator the water flows by gravity through a rack and screen chamber thence through a 40-inch diameter pipe line to the chemical mixing tank, then through the "round the end" baffled mixing chamber into the influent flume to the sedimentation basin. Four

solution tanks were constructed and two American made dry feed machines have been installed to feed sulphate of amlumina and also lime if necessary. All chemical feed is manually controlled with Roberts Filter Co. orifice boxes for the solution. A Simplex Venturi meter is placed in the 40 inch water line and if automatic feed control apparatus is desired in the future it can be connected to this meter.

Sulphate of alumina alone is fed into the raw water, in varying amounts depending on the turbidity. The

Looking Across Lake Marathon, One Source of Athens' Water Supply

present normal turbidity of 5 to 10 parts per million requires very little alum (about 3.5 parts per million) merely to react on that small amount of colloidal fine clay held in suspension.

Due to heavy algae growths it was found necessary to chlorinate before filtration and the writer decided to introduce all of the chlorine in the forms of prechlorination, employing chloramine treatment before sedimentation and filtration. Ammonia is introduced through a Wallace and Tiernan ammoniator into the 40 inch line after the water leaves the aerator. The chlorine is introduced into the water beyond the mixing channel,

Operating Floor, Filtration Plant, Athens, Greece. Operating Tables Equipped with American Indicating and Recording Gages by Simplex Valve & Meter Co., and Control Appurtenances by Roberts Filter Mfg. Co.

about 60 meters (197 ft.) after the ammonia is introduced. The sulphate of alumina is fed into the water 20 meters (65 ft.) after ammonia is introduced and 40 meters (132 ft.) before chlorination. Chlorine is introduced into the water through a Wallace and Tiernan vacuum type solution feed chlorinator. The relation of rates of ammonia feed and the chlorine feed have been held to about 1 ammonia to 1.6 or 1.7 chlorine. In actual amounts the dosages have been 0.23 p.p.m. ammonia and .36 to .37 p.p.m. chlorine. The above dosages produce from 0.2 to 0.25 p.p.m. excess (residual) chlorine in the water 36 hours later after passing through the filters and the 11,000,000 gallons middle service reservoir. About 0.15 p.p.m. is found in the mains about three miles from the plant. In the middle of July the relation of rates was changed to about .16 p.p.m. ammonia and 0.38 p.p.m. chlorine.

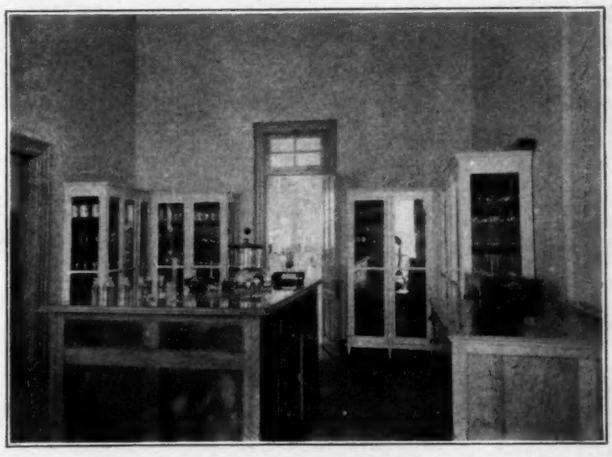
Nitrites are found in the system in varying amounts and apparently result from the use of ammonia. Change in the ratio of one ammonia to three chlorine largely eliminated the nitrites.

Sedimentation Basins

Sedimentation of the coagulated water is effected in three open, continuous flow sedimentation basins, each 15 meters (49.2 ft.) wide, 32 meters (105 ft.) long, and 5.3 meters (17.4 ft.) deep which provide a 3-hour detention period for the normal capacity of 56,700 cubic meters (15,000,000 gallons) per day, or about 4 hours for the present flow rate of 45,000 cubic meters (11,-600,000 gallons) per day. The basins are equipped with hanging slotted baffles to improve displacement and give an effective detention of the coagulated water.

Filters and Appurtenances

The filtration plant is equipped with ten 5,670 cubic meters (1,500,000 U. S. gallons) per day gravity filter



Chemical Laboratory, Filtration Plant, Athens, Greece

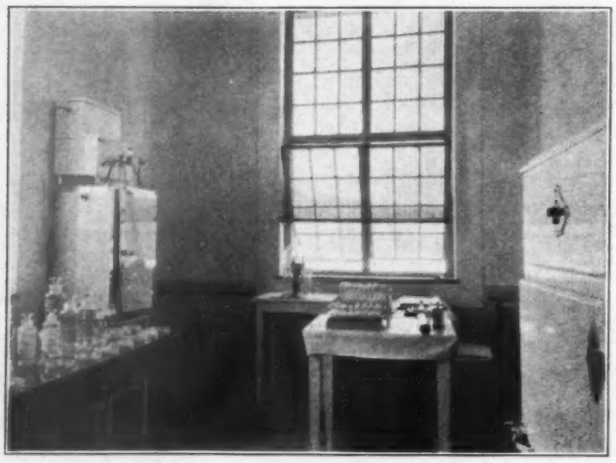
units equipped with Ludlow hydraulically operated valves; Simplex Valve and Meter Co. Venturi controllers, loss of head gauges, and rate of flow gauges. Roberts Filter Manufacturing Co.'s operating table appurtenances are installed on marble tables constructed of Pentelikon marble from Greece. The only pumping in the plant is that of the wash water. That is pumped from the clear water reservoir by Worthington centrifugal pumps (General Electric motors) to the 600 cubic meter (160,000 U. S. gallons) reinforced concrete covered reservoir located at the proper elevation on the hill adjacent to the plant. In case of emergency the filter may be washed with raw water. This is possible due to the fact that the aerator nozzles are set to operate at the same head as the overflow of the wash water reservoir. That is to say with the very good raw water of 5 turbidity, and opening the 24 inch by-pass between the aerator and the wash water reservoir lines the tank

may be kept full of clean raw water. This emergency operation causes the use of the rewash valve of the filter units extensively and we approve of washing with raw water only in case of necessity. All hydraulic valves are connected to the board through Roberts Filter Co.'s 4-way valves installed inside the tables, and the connecting pressure pipe lines to the valves are constructed of copper tubing, eliminating elbows and fittings other than the connecting pieces. All small valves and brass fittings in the gallery and in the plant are of Crane Co. manufacture. All cast iron fittings and pipe on the plant and in the gallery are of French Pont-A Mousson manufacture, with all flanged connections patterned after specifications and standards of the A. W. W. A. All sluice gates used on the basins and in the wash water recovery plant are of British manufacture (Ham Baker, Ltd.), and all railings are of Swiss manufacture (Georges Fischer). American made valves (Ludlow) were used throughout the plant.

Laboratory Control

In conjunction with the filtration plant is a fully equipped chemical and bacteriological laboratory in which bacteriological examinations of raw, aerated, settled, filtered, and delivered water are made daily and about 200 examinations of samples obtained from dead ends, and residence taps are made every month. Chemical examinations for alkalinity, residual chlorine, pH value, nitrites are now made daily. Total carbonate and non-carbonate hardness, chlorides, iron, nitrates, etc., are made every week. The laboratory employes methods of the American Public Health Association as prescribed in "Standard Methods." The results also show good water bacteriologically in the dead ends. The bacteriological counts of the finished water delivered to the city are extremely low. For example, one month the average in one c.c was 2.7 on agar and 2.2 for gelatine, and 4 on agar and 3 on gelatine in another month. The bacterial counts of the raw water are also very low in comparison with the river conditions in the U. S. A., namely, the counts for one month averaged 13 on agar, and 38 on gelatine and 19.5 on agar and 41.5 on gelatine in another month. Of these raw water samples inoculated into lactose broth, the 0.1 cc. portions were 100 per cent negative; the 1.0 cc. portions 93 per cent negative; and 10.0 cc. portions were 79 per cent negative. Bacteriological media is purchased from the Digestive Ferments Co. of Detroit.

Louis A. Geupel



Bacteriological Laboratory, Filtration Plant, Athens, Greece

The chemical data shows average pH of 7.4 or 7.5; chlorides average 27 or 28; traces of nitrites in the raw water; iron zero; total hardness averages about 200, 194 parts being carbonate hardness and only 6 parts non-carbonate. The hardness of the lake at Marathon is about 165 which is raised to 200 by the addition of the well water of Kokinara and the tunnel weeper water.

Waste Water Recovery Plant

The water recovery plant is merely a surge tank, which receives the dirty wash water and the clean overflow and drainage and allows the water to be settled again by flowing continuously through a control sluice gate into two Link-Belt straight line settlers. From the settlers the sludge is dragged to the hoppers by the Link-Belt scrapers and the settled top water overflows four weirs to the pump suction well. From the pump suction well the water is pumped by automatic float controlled Worthington centrifugal pumps into the influent main to the plant and passes through the aerator and entire filtration process again. This salvaging plant is most interesting and the results of several months show unrecovered total plant waste amounting to but 0.33 per cent of the raw water treated. That is to say, with the original plant the total loss of 1.76 per cent was reduced practically 85 per cent by operating the recovery plant. The saving of water amounts to about 140,000 U. S. gallons per day which is equivalent to roughly 55,000,000 gallons per year. As explained previously the dry season in the vicinity of Athens lasts about 8 months and some years very little rain falls at all, so the stored water must be carefully conserved when the dam at Marathon is not overflowing. Because of this the recovery plant is a valuable addition to the plant.

A Distribution Feature of Interest

An interesting feature of the distribution of water is the fact that very few residences have their plumbing system directly connected to the mains. The houses have tanks on the roofs which are filled from the mains. These tanks were a necessary part of the old water system which was only capable of supplying water to different sections of the city on alternate days. As rapidly as plumbing can be renovated to stand the pressures carried in the mains direct connections will be enforced and the roof tanks then abandoned. The use of these tanks with resultant low head on the fixtures and also the past habits of water conservation added to the fact that but 50 per cent of the population is connected for the low consumption of 5.5 gallons per capita.

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Los Angeles Water Laboratory Enlarged

Greater facility and efficiency in the operation of the laboratories of the Bureau of Water Works and Supply is expected to result from the rearrangement and enlargement of its laboratory facilities. The staff now is operating under its new arrangement.

The following rooms are included in the group on the tenth floor of the Second street building: Office of Dr. Carl Wilson, in charge of the laboratory; office of R. F. Goudey, sanitary engineer; sterilizing room, research laboratory, plankton laboratory, dark room, chemical laboratory, record room, test laboratory.

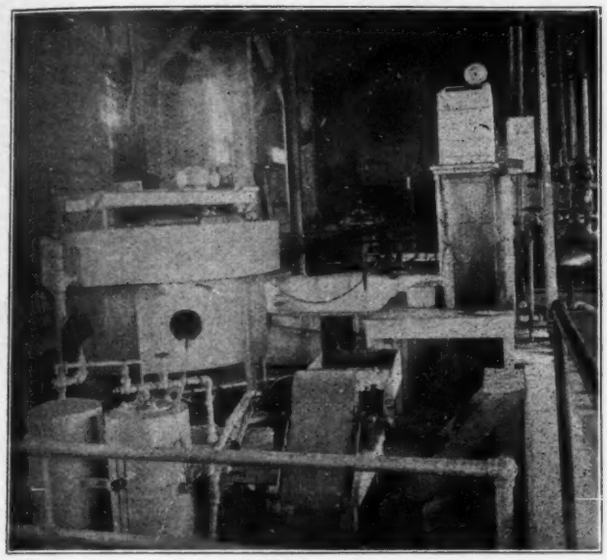
New equipment installed includes a Boron testing equipment in which the electrometric titration of boric acid is employed in determining Boron in water samples.

PERFORMANCE OF THE LAUGHLIN PROCESS OF SEWAGE TREATMENT

A Report Covering Investigation and Tests Made at the Experimental Plant at Coney Island, New York

By E. HURWITZ, Sanitary Chemist, Chicago, and S. I. ZACK,* Sanitary Engineer, Chicago

THE Coney Island experimental unit of the Laughlin process for sewage treatment is located at Sewage Pumping Station No. 3 of the Department of Sanitation, Brighton Beach, Coney Island, N. Y. Over a period extending from Aug. 29 to Sept. 16, 1932, a series of tests were made on this plant to determine the efficiency of the process from a standpoint of operating



Coney Island, N. Y. Experimental Unit, Employing the Laughlin Process of Sewage Treatment

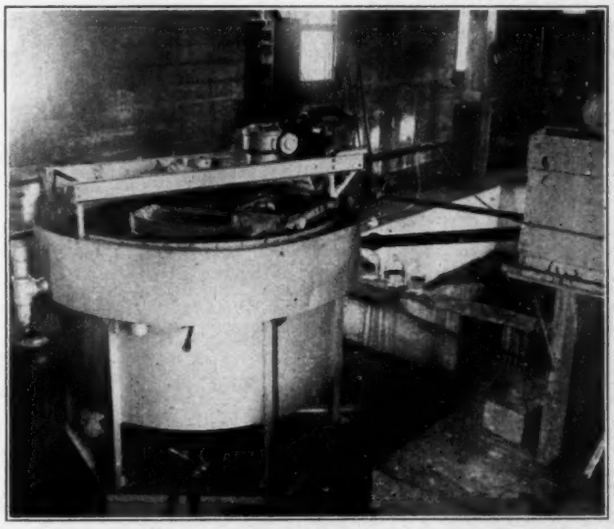
and analytical results. The sewage treated was from the heart of the Coney Island amusement center at the height of the season, located in an otherwise purely domestic area.

Description of Equipment and Operation

The testing station was operated 24 hours a day on a schedule of two 12-hour shifts. Sewage was pumped with a diaphragm pump, from a wet well following bar screens, into a baffled lime-paper-sewage mixing box. This box was 4 ft. long, 1 ft. 6 in. deep and 1 ft. wide. A lime-paper mixture in the form of a paste was discharged every 7½ minutes at the inlet of this box by means of a motor driven chain type conveyor carrying bronze flights, which passed through a wooden reservoir containing a measured quantity of the lime-paper paste. Variations in the amount picked up per flight and in the moisture content of the lime-paper mixture made it difficult to obtain uniform application of lime and paper to the sewage. The lime and paper was thoroughly mixed with the sewage in the first compartment of the baffled mixing box by a continuously operated motor driven propellor. Solutions of either ferric chloride or sulphate were added drop by drop in the last compartment from a Woulf bottle fitted with a pet cock. The amount of iron solution used was determined by measuring the flow from the Woulf bottle in cubic centimeters per minute.

The chemically treated sewage flowed by gravity into the central well of a 6 ft. circular steel tank, with a sewage depth of 3 ft. 5 in. at the side and, a truncated cone shaped bottom, sloping 31½ in. horizontal and 8½ in. vertical to a central sump 9 in. deep and 9 in. in diameter. The tank was equipped with a mechanism for scraping the sludge to the central sump and with a Laughlin magnetite filter and magnetic filter cleaner. The capacity of the tank excluding the volume above the screen and filter was 89.6 cu. ft. The net filter area was 11.15 sq. ft. and the effective settling area was 14.1 sq. ft. These volumes and areas were used in computing the detention periods, filter and settling rates. Sludge was removed through a valve at the bottom of the tank. The effluent was chlorinated with a Wallace and Tiernan chlorinator and finally measured by means of a 90° V-notch weir. Special short tests were made to determine the efficiency of the Laughlin filter in removing suspended solids. Also tests to determine the feasibility of dewatering the sludge from this process for ultimate incineration were made. An Oliver vacuum filter 1 ft. long and 1 ft. in diameter was used for this purpose.

Samples of raw sewage, unchlorinated and chlorinated effluent were taken every half hour and composited for each 12 hour period. The flows and operating data were calculated and average on a similar basis.



Coney Island, N. Y. Laughlin Settling Tank with Magnetite Sand Self-Cleaning Filter at the Top

Operating and Analytical Data

The operating data pertaining to flows, detention periods, settling and filtering rates are shown in Table I.

Non-uniform pumping tended to overload or underload the Laughlin clarifier for short periods of time until adjustments could be made. The rates and flows are therefore averages computed from very frequent weir

*Formerly Assistant Engineer, Chicago Sanitary District and now Sanitary Engineer associated with H. W. McKenzie Co., Dearborn, Mich., representing Filtration Equipment Corporation.

TABLE I—SUMMARY OF OPERATION DATA

Samples Averaged	No. of Hours per Day	Flow in Gallons for Hours Indicated Rate	Flow in Gallons for Hours Indicated Treated	Based on Rate of Flow Detention Period in Hrs.	Filtering Gal. per Sq. Ft. per Min.	Settling Gallons per Sq. Ft. per 24 Hrs.
Day	12	6,930	5,972	1.16	0.86	987
Night	12	7,020	6,827	1.14	0.87	995
Combined ..	24	13,950	12,799	1.15	0.87	990

TABLE II—SUMMARY OF CHEMICALS AND PAPER USED PER MILLION GALLONS OF SEWAGE TREATED

Samples Averaged	No. of Hours per Day	Chemicals—Pounds Per Million Gallons Paper	Lime as CaO	Fenic Chloride	Chlorine
Day	12	420	980	159	61
Night	12	350	820	164	62
Combined...	24	385	900	161	62

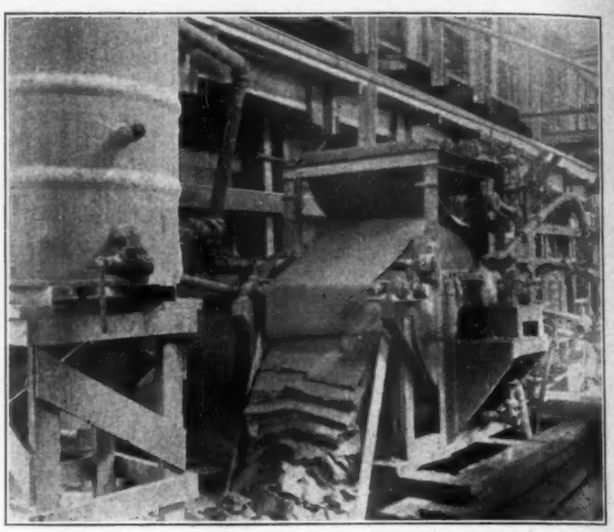
readings. No allowance for space occupied by sludge was made in computing the detention periods. Upward flow occurs in the area below the filter and it was therefore assumed that this area was not available for sedimentation. The settling rates per square foot are based on the surface area of the central portion only. Although the filtering and settling rates were not excessive, the settling capacity was somewhat limited. The calculated detention period on its entire volume averaged 1.15 hours, but if allowance is made for space occupied by sludge and for short circuiting, the actual detention period would be considerably less.

Table II shows the chemicals used per million gallons of sewage treated. The amounts of chemicals used in the process are calculated from weights recorded at the plant and from the analysis of the solutions and mixtures used. All iron compound is calculated to ferric chloride although the sulphate was used for a few days.

A summary of chemical analyses of the raw sewage, chlorinated and unchlorinated effluents in parts per million and the per cents removal according to day, night and combined flow is shown in Table III. The results of chemical analyses for each 12 hour period are shown in Table III.

Chemical analyses were made according to the standard methods of the A.P.H.A. Chlorine in samples taken from dissolved oxygen determinations was neutralized as recommended by Theriault in the U. S. Public Health Reports, Supplement No. 90. Residual chlorine and alkalinity of samples for biochemical oxygen demand tests were neutralized and seeded with settled raw sewage.

The high concentration of total solids in raw sewage and low volatile content compared to suspended solids indicates the presence of large amounts of mineral matter in solution. The night sewage although considerably weaker in concentration than the day sewage had a higher volatile content. Several features at Caison No. 3, such as the addition twice each day of sodium nitrate to the sewage in the wet well and the discharge through the sewers from a large number of establishments featuring salt water baths contributed toward increasing the total solids content of the sewage.



Vacuum Sludge Filter in the First Laughlin Experimental Plant at Dearborn, Mich.

An effluent having a pH of approximately 10.0 was maintained throughout the test. Caustic alkalinity was present on only three occasions.

The combined sewage, day and night flow, was of average strength, 132 p.p.m. suspended solids and 132 p.p.m. B.O.D. The effluent obtained from the process was well clarified and had an average B.O.D. of 41 p.p.m. and 28 p.p.m. for the unchlorinated and chlorinated effluents respectively. The suspended solids of these effluents were 24 p.p.m. and 12 p.p.m. respectively. The B.O.D. samples were incubated at room temperatures which ranged between 20° C. and 30° C. and therefore

TABLE III—SUMMARY OF ANALYTICAL RESULTS AND PER CENTS REMOVAL

Source of Sample	Total Solids—Total	Total Solids—Volatile	Total Solids—Pct. Volatile	Suspended Solids—Total	Suspended Solids—Volatile	Suspended Solids—Pct. Volatile	5 Day B.O.D.	Diss. Oxygen	Alkalinity—Phenol	Alkalinity—M. O.	pH	Res. Chlor.
	Day 9 A. M. to 9 P. M.—Sewage Treated, 5972 Gals. Rate of Flow, 6930 Gals. Per Day											
Raw Sewage p.p.m.	3181	1342	42	181	136	75	173	..	..	...	7.4*	..
Unchlor. Eff. p.p.m.	2785	984	35	24	16	67	43	3.7	39	178	9.9	..
Chlor. Eff. p.p.m.	2989	1006	34	12	6	50	31	5.7	71	183	9.9	0.4
Unchlor. Rem. Pct.	12	27	..	87	88	75	75	..	..	...	..	..
Chlor. Rem. Pct.	6	25	..	93	96	..	82	..	..	...	..	..
	Night 9 P. M. to 9 A. M.—Sewage Treated, 6827 Gals. Rate of Flow, 7020 Gals. Per Day											
Raw Sewage p.p.m.	769	416	54	84	71	85	92	..	..	...	..	..
Unchlor. Eff. p.p.m.	1038	466	45	17	8	47	40	4.1	71	174	10.0	..
Chlor. Eff. p.p.m.	1068	506	47	9	6	67	24	6.1	83	174	9.9	0.3
Unchlor. Rem. Pct.	+26	+10	..	80	89	..	57	..	..	...	..	..
Chlor. Rem. Pct.	+35	+12	..	89	92	..	74	..	..	...	..	..
	Day and Night Combined—Sewage Treated, 12,799 Gals. Rate of Flow, 13,950 Gals. Per Day											
Raw Sewage p.p.m.	1979	919	47	132	105	80	132	..	..	...	..	..
Unchlor. Eff. p.p.m.	1912	725	38	21	12	57	41	3.9	59	176	9.9	..
Chlor. Eff. p.p.m.	2028	756	37	10	6	60	28	5.9	77	179	9.9	0.4
Unchlor. Rem. Pct.	3	21	..	84	89	..	69	..	..	...	..	..
Chlor. Rem. Pct.	+3	18	..	92	94	..	79	..	..	...	..	..

*One Determination.
Rem. = Removal.

TABLE IV—SUMMARY OF SLUDGE PRODUCED BASED ON SUSPENDED SOLIDS, TOTAL SOLIDS, CHEMICALS AND AS DRAWN FROM CLARIFIER

Method of Calculation	Pounds—Total			*Pounds per M. G. Sewage Treated		
	Day	Night	Combined Day and Night	Day	Night	Combined Day and Night
Suspended solids removed	84.3	44.0	128.3	595	312	907
Chemicals precipitated	34.3	37.3	71.6	243	264	507
Total lbs. sludge = chem. + susp. sol.	118.6	81.3	199.9	838	576	1414
Sludge drawn from clarifier	....	....	228.4	...	...	1615

*Total flow treated—Day, 65,700 gal.
Night, 75,400 gal.
Combined, 141,100 gal.

may be somewhat higher than would be obtained at constant temperature of 20° C.

Solids Balance

In order to appreciate more fully the action taking place in this process from a quantitative standpoint, the sludge produced has been calculated on the basis of:

(1) Suspended solids removed as shown by analyses plus the theoretical amounts of sludge precipitated by chemicals added.

(2) Solids as determined by moisture content and gallons actually drawn as sludge from the bottom of the Laughlin clarifier.

Table IV shows the amounts of solids produced as calculated by these methods.

Miscellaneous Tests

Following the continuous tests on the process, some additional tests were made to determine the filtrability of sludge removed from the clarifier, and the efficiency of the Laughlin magnetite filter and cleaner for various rates of flow.

TABLE V—DEWATERING OF SLUDGE WITH OLIVER VACUUM FILTER

Test No.	Time of Test (Min.)	Gal. Wet Sludge to Filter	Pct. Solids in Sludge	Lime Conditioner. Pct. of Dry Solids	Sludge Cake Thickness in Inches	Sludge Cake Pct. Moisture	Sludge Cake Pct. Sulphur	Pct. Ash	B.T.U. (Dry Basis) Total Solids	B.T.U. (Dry Basis) Volatile Solids	Lbs. of Solids—Dry Basis Filtered	Lbs. of Solids—Dry Basis Per Sq. Ft.	Lbs. of Solids—Dry Basis Per Sq. Ft. per Hr.
1.	..	4.1	5.0	0	1/12–1/8	70.5	1.39	41.25	4441	7560	3.4	1.08	..
2.	15	8.2	4.8	3.8	1/6–1/5	73.1	1.41	41.00	4570	7590	3.3	1.05	4.2
3.	15	8.2	4.5	8.1	1/6	70.6	1.44	43.15	4120	7250	3.1	0.99	3.9
4.	20	8.2	5.1	50.0	1/7–1/6	70.2	1.37	49.15	3850	7660	3.5	1.11	3.3

TABLE VI—TESTS ON EFFICIENCIES OF SETTLING IN LAUGHLIN TANK AND FILTERING THROUGH MAGNETIC FILTER

Test No.	Duration of Test, Hrs.	Gal. per Min.	Detention Period, Hrs.	Filtering Gal. per Sq. Ft. per Min.	Settling Gal. per Sq. Ft. per 24 Hrs.	Cleaner Mechanism Times Operated	Minutes On	Minutes Off	Raw Sewage Influent	Below Filter	Effluent
1.	1.0	8.7	1.29	0.78	890	3	28	32	140	17	5
2.	1.0	13.7	0.81	1.23	1400	5	49	11	120	59	4
3.	1.0	11.8	0.95	1.06	1200	4	43	7	113	58	7

TABLE VII—DAILY RESULTS OF CHEMICAL ANALYSIS, PARTS PER MILLION

D = Day.
N = Night.

Date 1932	Time of Day	Gallons Treated per Day	Suspended Solids Total Influent	Suspended Solids Total Unchlor. Effluent	Suspended Solids Total Chlor. Effluent	Suspended Solids Volatile Influent	Suspended Solids Volatile Unchlor. Effluent	Suspended Solids Volatile Chlor. Effluent	5-Day B. O. D. Influent	5-Day B. O. D. Unchlor. Effluent	5-Day B. O. D. Chlor. Effluent	Dissolved Oxygen Unchlor. Effluent	Dissolved Oxygen Chlor. Effluent	Alkalinity Phenolphthalien Unchlor. Effluent	Alkalinity Phenolphthalien Chlor. Effluent	Alkalinity Methyl Orange Unchlor. Effluent	Alkalinity Methyl Orange Chlor. Effluent	pH Unchlor. Effluent	pH Chlor. Effluent
8/30/31.	D	9380	312	25	3	220	14	2	240	49	33	3.9	4.9	34	78	188	182	.....	.....
	N	6610	54	26	10	24	6	6	92	48	29	5.1	6.8	118	88	214	162	.....	.....
8/31....	D	8260	160	13	22	138	9	..	135	43	34	4.1	5.2	38	58	178	162	9.8	9.7
9/1.....	N	9380	117	33	12	98	..	8	85	52	12	4.5	6.2	50	72	112	150	10.0	10.0
9/1—2..	D	6190	238	20	8	152	8	2	140	28	15	3.3	5.4	42	74	156	174	9.6+	9.6+
	N	8770	162	22	13	100	11	7	55	23	19	3.7	6.8	42	74	132	146	9.6+	9.6+
9/2—3..	D	7430	120	34	10	114	29	7	250	42	26	2.3	5.3	38	42	186	134	10.1	10.1
	N	5050	48	18	4	..	11	2	102	24	26	4.1	6.1	56	66	162	128	9.9	9.9
9/3—4..	D	4660	146	26	12	122	17	9	170	36	45	3.8	6.1	100	140	382	386	9.9	10.0
	N	4460	70	17	9	64	11	5	75	17	33	4.3	6.7	152	158	320	344	9.8	9.8
9/4—5..	D	3750	216	30	10	120	13	4	130	44	26	3.4	5.6	34	66	148	150	10.0	10.0
	N	8320	84	24	7	46	12	3	130	42	25	2.4	5.9	62	64	180	158	10.0	9.9
9/5—6..	D	4060	120	16	10	110	15	8	75	31	19	3.4	6.3	38	86	186	220	9.9	9.8
	N	6780	130	6	11	122	4	7	57	29	18	1.9	3.4	84	68	168	174	10.0	9.8
9/7—8..	D	5710	132	23	13	110	22	11	160	31	25	4.9	5.5	26	66	124	166	.....	.....
	N	5170	50	5	11	41	3	9	48	30	13	5.7	6.4	98	76	152	134	.....	.....
9/8—9..	D	4600	171	29	17	..	..	..	215	44	32	4.5	7.3	20	28	172	122	10.1	10.1
	N	6700	70	15	7	..	..	..	112	58	25	4.3	6.3	50	86	192	186	10.3	10.1
9/9—10.	D	6000	134	16	8	..	..	..	210	62	56	3.8	5.3	26	66	128	158	9.9	9.4
	N	6790	72	14	6	..	..	..	135	52	40	4.5	6.4	68	78	138	158	10.1	10.1
9/10—11	D	5850	138	33	18	..	..	..	180	68	36	3.6	5.9	34	76	116	156	10.1	10.1
	N	7060	61	11	..	..	..	..	120	62	..	4.3	..	84	..	130	...	10.3	.....

Table V shows the operating data of the dewatering tests, and analyses of sludge before and after filtration for various amounts of lime used as conditioner. The lime used for conditioning was added as milk of lime diluted to contain 3 pounds of lime in 12 quarts of water. These tests were on such small scale and over so short a time that they may only be considered qualitative. They serve to indicate, however, the possibility of dewatering the sludge from the process on vacuum filters. Additional lime is needed for conditioning but excessive amounts do not improve the filtrability of the sludge. Increasing amounts of lime correspondingly increases the ash content and reduces the B.T.U. value of the sludge, which is of importance when final disposal by incineration is contemplated.

Table VI shows the operating and chemical data of the tests to determine the efficiencies of settling and filtering through the magnetite sand and operation of the magnetic cleaner for various rates of flow. This data is based on frequent observations of operation, head loss, flow measurements and sampling of raw sewage and liquors above and below the filter during each run. The chemical dosage applied amounted to approximately 650 pounds of lime, 250 pounds of ferric chloride and 280 pounds of paper per million gallons.

It is evident that as the detention period was reduced by greater flow less solids settled by gravitation and more floc was present below the filter, consequently adding to the load on the filter and cleaner. The maximum efficiency of operation, performance and quantities of sewage handled by the Laughlin clarifier can therefore be attained by a proper balance between settling time and filter rates.

Summary and Discussion

The data presented indicate a very satisfactory removal of suspended solids, approximately 90 per cent. The unchlorinated effluent of the combined day and night flow contained only 21 p.p.m. This high removal of suspended solids is due in a large measure to the efficient action of the Laughlin magnetite filter.

The reduction of 5 day B.O.D. by the Laughlin process (unchlorinated effluent) was 69 per cent. Chlorination increased the per cent removal to 79 per cent. The average B.O.D. in the effluent from the combined day and night flow was 28 p.p.m.

There was a wide variation in the amounts of chemicals applied when computed on the basis of flow. Very good results were obtained with the lower quantities of lime. This would indicate the need for closer control in the application of chemicals than was possible at the Coney Island station to effect the greatest economies and efficiencies in operation of a plant of this kind. More satisfactory operation would be obtained by use of a tank designed to give the proper relation between settling and filter rates; equipment to allow the proportionate feeding of chemicals according to flow and concentration of sewage; and by use of mechanisms to facilitate the formation of a large, rapidly settling floc.

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Four States Section Will Meet At Cherry Blossom Time

Word from Charles Becker, Secretary of the Four States Section of the A. W. W. A., states that the meeting of this Section is to be held in Washington, D. C., April 27th and 28th during the period when the famous cherry blossoms will be in full bloom. That sight alone should be worth the trip to Washington.

Arizona Public Health Association to Meet at Tucson

The sixth annual meeting of the Arizona Public Health Association will be held in Tucson, Ariz., at the Santa Rita Hotel, April 17, 18 and 19.

In addition to paper on many phases of public health work the following are of particular interest to men engaged in water works and sewerage practice.

APRIL 18TH

Chlorination in Sewage Treatment—A. M. Rawn, Asst. Chief Engineer, Los Angeles County Sanitation District.

Algae Control and Reducing B.coli Count in Uncovered Reservoirs—Phil Martin, Water Supt., Tucson.

APRIL 19TH

Tracing Underground Pollution of Water Supplies—Dario Travaini, Supt. Sewage Plant, Phoenix.

Discussion—Harold Schwalen, Asst. Irrigation Engineer, University of Arizona.

Odor Nuisance—Walter Johannessen, Deputy City Engineer, Phoenix.

Cost of Operating Tucson Water Department—A. L. Burch, Asst. Water Supt., Tucson.

New Water Supply for Grand Canyon, Arizona—G. L. Davenport, Asst. Engineer, A. T. & S. F. Ry., Los Angeles.

Chlorination for Odor Control—S. J. Norman, C. E., Casa Grande.

Recontamination or Aftergrowths in Water Mains—Carl Wilson, Director of Sanitation, Dept. of Water and Power, Los Angeles.

Flourine Facts for Water Works Operators—H. V. Smith, Asst. Prof. Agricultural Chemistry, U. of Arizona, Tucson.

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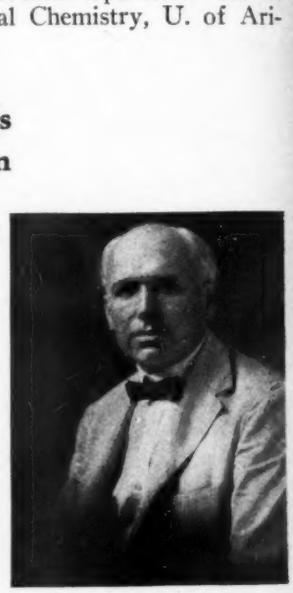
James E. Gibson Heads Engineering Organization



James E. Gibson, Pres., James E. Gibson, Inc., Engrs.

Announcement has just been received of a new engineering organization — James E. Gibson, Inc., Engineers — established in Charleston, S. C., and headed by James E. Gibson, Superintendent of Water Works at Charleston, S. C.

The new firm will specialize in general consulting practice in the field of water works and sewerage, including the evaluation of properties and establishments of rate schedules. The firm will offer chemical and bacteriological laboratory service and will assume management and operation of plants. One of their announced specialties will be "the up-building of run down works" and they are prepared to supply financial accounting and C. P. A. services also.

Associated with Mr. Gibson, who has had long years of varied experiences in operation and management of water works properties, will be the following—F. B. McDowell, Vice-Pres., Chas. L. Vann, C. P. A., Dr. F. L. Parker, Chemist-Bacteriologist, and Edwin Gibson, C. E., Secretary of the firm.

The firm offices are located at 133 Ashley Ave., Charleston, S. C.

SELLING THE WATER WORKS TO THE PUBLIC

By A. F. PORZELIUS

Superintendent, City Water Company, Chattanooga, Tenn.

A. F. Porzelius

THE problem of selling the water works to the public resolves itself into making the water consumer conscious of what is behind the faucet.

Water is looked upon by the consumers as being an article of no value since it is evident to them only in the form of rain, rivers, springs or the like, and it is only when the water department finds it necessary to discontinue service, either through making repairs, a breakdown or the shutting off of water for failure to pay the bill that the consumer becomes conscious of the water supply, or lack of it, and the water department is told in no uncertain terms his or her opinion for such failure to provide this service.

This problem of acquainting the public with what is necessary to insure a pure and wholesome water supply at all times is one which is of interest not only to privately owned operators, but it is of great importance to all of the municipal water departments, since we are both dependent upon the good-will of the public.

We water works men have been backward in comparison with the gas and electric industries in selling the public on our commodity or service, and we have failed to advise it of our problems, but I do think that we are really in a much better position to arouse the interest of such people in their water supply, since this service is one of the most necessary services in the carrying on of human life and the proper functioning of a modern community.

Most water works operators are lost in the technical end of their work as they are striving for perfection along this line, and they do not realize that it is a part of their job to inform the consuming public of the technical problems confronting them, and of the large expenditures which are necessary in order to supply the public with a pure and wholesome water. This question resolves itself into three factors: First, Character of water supply; Second, Physical Plant, and Third, Public Relations.

Character of Water Supply.—There is a great amount of variation in the character of the raw water which is obtainable at the various plants throughout the country, but through modern technical efforts it is now possible to present to our consumers a water which is pure and wholesome, and in many cases hard waters can be softened to a point where they are not particularly objectionable to our consumers. Through modern filter plants and sterilization all waters can be made bacteriologically pure so from the technical treatment, criticism of the character of the water supply can be reduced to a minimum. With a good supply furnished to our consumers, the next question is that of the physical plant.

Physical Plant.—All water works are alike in the general character of their physical properties, namely, a pumping station, quite often a filter plant, sometimes a softening plant, and always a distribution system with fire hydrants and service connections through which the water is sold either by a flat rate or meter basis. In addition there are often elevated tanks, standpipes or reservoirs located at the high points in the territory. What is attractive about this physical construction which appeals to our consumer? There is really very little, as that part which requires the greatest amount of expenditure in order to give service to our consumers is buried underneath the ground in the form of our distribution system, and except for the fire hydrants or meter boxes there is no part of this investment which can be seen, and usually these pass notice. I am reminded of this inattention to these details by the fire chief in one of our smaller communities who painted all of his fire hydrants a bright yellow, and one of the citizens of the community met him on the street and asked him, "Why in the world did you paint these fire hydrants yellow, I never knew there were so many in town before?" and the chief answered him, "That's the reason they are painted yellow."

Usually a standpipe is considered as an eyesore so this leaves us only the pumping station, filter plant and reservoirs which can be made attractive and interesting to the public. The buildings at the pumping station and filter plant should be well maintained; that is we should keep them clean and well painted, the windows should be washed and the machinery and other appurtenances should be free from oil and grease and all brass work should be shined up bright. Soap and water and a little paint are really very effective around any pumping station or filter plant and their cost is slight. Good housekeeping not only makes an excellent impression upon the visitor at your plant but improves the morale of your employes.

The grounds around our buildings and around the reservoirs can be made attractive at very little expense by keeping the grass cut and planting flowers and shrubs. Visitors to such a plant will just naturally feel that the water supply is well looked after. With a good water supply and the physical plant well maintained the most important problem then is that of public relations.

Public Relations.—Volumes have been written on this very important subject but it really simmers down to only two words: "making friends," and how best can we proceed in order to make friends for our water departments or companies. A man may have a heart of gold but be gruff and discourteous and it is thus a very difficult matter for him to make friends. In a like manner the water department is confronted with the same situation so courtesy is one of the most important assets in our problem of making friends, and every employe working for the water department or company must be impressed with the fact that courtesy is expected of him at all times.

This is a rather difficult thing to do at times, but there is a feeling of satisfaction in being able to soothe the

irate consumer and have him leave your office feeling that the water works is not such a bad place after all. A smile is a thing of wonderful help in our dealings with the public, but there should be sincerity behind the smile because the public is quick to realize when smiles are superficial.

We must teach our employes to think in the terms of being an important part of our organization since regardless how high or how low they are in the scale of employ, each and everyone of them have an important function to perform, and while the head of the organization may strive in every way to gain the good-will of the public, this work may be torn down by the act of some employe who feels that his part in the organization is not important.

The teller on the window at the office who takes in the money, and who receives many complaints, can often placate the consumer by explaining in a common sense way with courtesy and tact, so that the consumer will leave satisfied and thereby avoid ill feeling and further expense of follow-up on the part of the company.

The meter readers who travel over the entire community, and let me tell you, they are important members of your organization as they meet more of your consumers than you possibly can, should be neat in appearance and always be courteous in their contact with the consumer.

If you have a complaint man or adjustor, and his job is an extremely hard one to fill, he should possess all the tact and finesse of a diplomat. He must be fair at all times and should have a thorough understanding of the public, as people do not understand in most cases items such as the reading of the meter, or how a meter works, or the wastage of water through a small leak, all of these items which are simple to us because we meet them in our everyday life, but which are foreign to our consumers.

The men who make the repairs to mains and services in the street can often win a host of friends for the company or department by making repairs at a time when the consumer may be least inconvenienced since most people appreciate thoughtfulness. In connection with some construction work we had a very interesting experience in the laying of a new main on one of our business streets. Knowing that the public always voiced considerable criticism when a street was being torn up we prepared a sign which could be placed at each end of our ditch stating "The City's Growth Necessitates This Inconvenience, Please Bear With Us For the Short Period of This Work, City Water Company of Chattanooga." Instead of having criticism on the construction work which tore up the people's streets we had a great deal of favorable comment, not only from the public but also from the newspapers, and having no kick we felt well repaid for our efforts.

The superintendent or head of the department should strive to make friends through contacts such as are developed in the civic organizations and by joining into civic activities which mean much to a community and through which he will know and be known.

Then the public should be informed through your newspapers by judicious use of paid advertising, which can be utilized to create an interest in the water works as there are so many interesting problems in connection with the preparation and distribution which can be shown to advantage in this way. Sometimes a message can be carried in the reading columns of the newspapers as the reporters can write a nice story about some improvement which you are going to make, or which has been made, or some phase of your operation which is unusual, and for this reason it always pays to have friends among the newspaper reporters. Give them news when you have it; they need it to fill up their newspapers and they can help you materially in many cases.

Invite the public to visit your plant, sometimes through the aforesaid paid advertising, always through an invitation by means of a nice sign in your office. Many of them never know that a water works plant exists, do not know where it is, and you should endeavor by every means possible to have them visit you.

All school children should be invited to visit the water works plant accompanied by their teachers and a study should be made by them of the processes which are necessary in the preparation of your water supply. In my city it is a part of their course to bring the school classes out to the water works plant each year, and the child must write an article about the visit. In some cities interest is aroused among the school children by offering a prize for the best essay on the water works and it is but natural that if the children are interested they are going to ask questions of their parents and thereby arouse the interest of the adults. All of these factors assist greatly toward the making of friends and are a wonderful asset to any water works plant as it takes away from the consumer the feeling that such a plant is purely a mechanical thing and make it known to him that there is a heart and soul existing in such an organization.

This building of public relations is not accomplished in a few months but takes years of effort and continuous and everlasting application toward keeping in the good graces of the public and for this reason there can never be a letdown in any organization in its attitude toward the public, since the public is a fickle mistress. Goodwill is an intangible article of priceless value, guard it well and keep it.

Acknowledgement.—The above paper was read before the Tennessee Short School for Water Works Operators, held at Knoxville, Tenn., December, 1932.

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Ohio Public Water Supplies

The total population of Ohio, according to the 1930 census, was 6,646,697, of which 4,989,999 lived in the 110 cities and 752 villages of the state. According to the *Ohio Health News* for Feb. 15 72 per cent of the total population, or 96 per cent of the population within the municipalities of the state are provided with public water supplies. Of the total population supplied, 74 per cent are furnished with water from surface sources and 26 per cent with well water.

Other interesting data show the number of small villages provided with public water supplies. Excluding the suburban villages which secure their water from an adjacent city, there are 48 villages between 2,500 and 5,000, 104 villages between 1,000 and 2,500, 60 villages between 500 and 1,000, and 12 villages less than 500 in population which have their own public water supplies.

Of the total 752 villages in the state only 287 are provided with public water supplies. However, most of the villages without a public water supply are quite small, only 36 being over 1,000 in population.

The number of privately owned water works systems is relatively low, there being 16 cities and 20 villages which are supplied by private companies. These 36 municipalities have a total population of about 232,000.

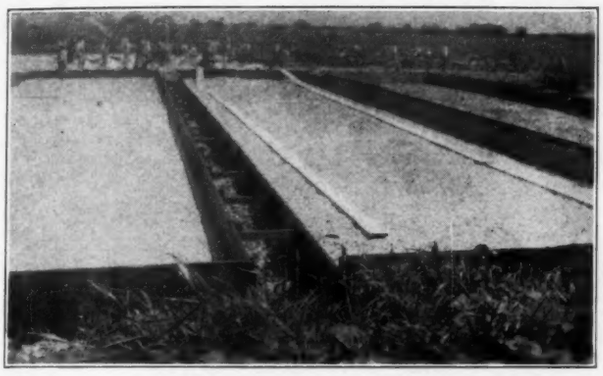
SLUDGE DRYING BEDS SAN ANTONIO SEWAGE TREATMENT PLANT

Construction and Operation Costs

By W. S. Stanley
Chief Chemist and Superintendent,
Sewage Treatment Plant, San Antonio, Texas

THE original design of the San Antonio Sewage Treatment Plant called for lagoons as the means for disposal of the digested mixed activated and crude sludge. Under existing conditions this would mean the discharge of lagoon effluent into the San Antonio River. Such procedure was considered unwise, and it was therefore decided to build sufficient open-air drying beds to take care of the digested sludge.

It was contemplated at the start that one-half of a square foot of drying area per capita population would be sufficient. This, considering the connected population of 181,500, would require 90,750 square feet of drying area. Actually only 84,000 square feet were constructed and put into operation and it has since been found that to insure proper drying during wet months, a considerably larger area will be necessary.



San Antonio Sludge Drying Beds, Showing Method of Construction. The Space Between Wooden Partition Wall Was Afterwards Filled with Earth and Tamped

Sludge Drying Bed in Various Stages of Dryness, San Antonio Sewage Plant. Note Temporary Nature of Construction Using Wooden Flumes and Spouts

The sludge beds are 42 in number, each 20 feet by 100 feet. The beds are built on clay soil. Rows of vitrified tile drain, placed loosely in the center of each bed connect with 6-inch laterals. Each bed consists of a 4-inch layer of coarse gravel, followed by 4 inches of ¾-inch gravel and 4 inches of washed sand. The sludge is delivered to the drying beds by means of a plunger pump and is distributed through a system of pipes and troughs to individual units. A tool house and garage adjoins the sludge drying beds. It also houses a motor for a small experimental sludge grinder.

One-half of the sludge beds has plain earth embankment partitions; the other half has earth embankment lined on both sides with 2-inch creosoted lumber.

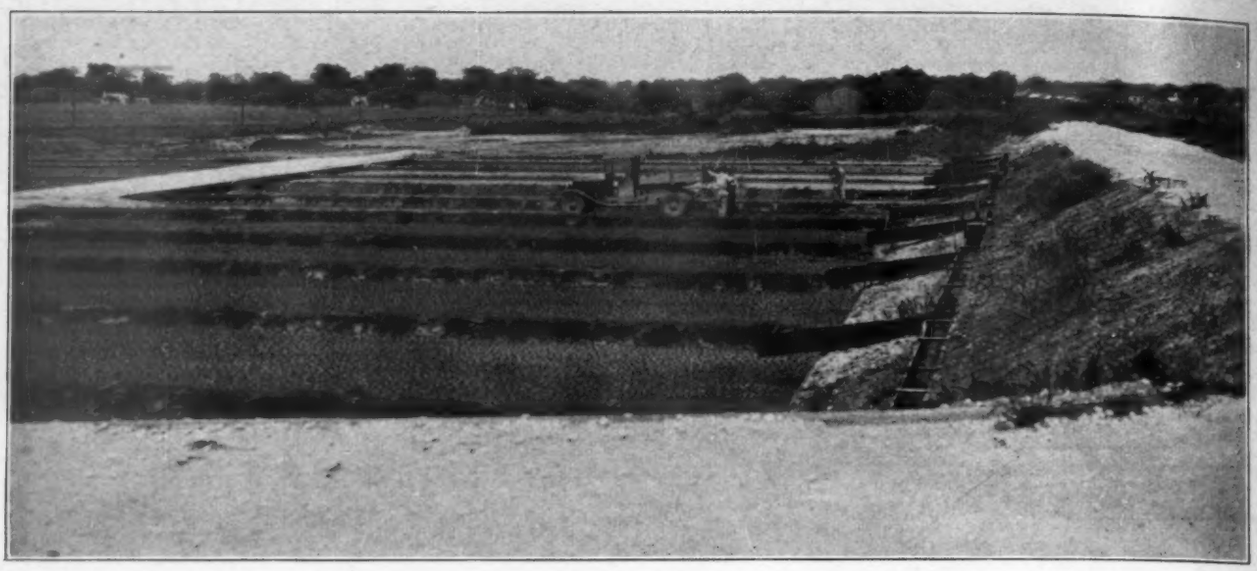
The dried sludge is being removed by trucks, backing into the beds on movable runners. Each runner, 22 inches wide and 8 feet long, made of 2-inch lumber, is light enough to be easily carried from one bed to another by two men. Cotton-seed forks are being used for scooping off the sludge. This method of removal has proven entirely satisfactory.

It is estimated that approximately one yard of sand is removed with every two tons of sludge, calculated on dry basis. One cubic yard of dried sludge (average moisture 62 per cent) weighs approximately 1,300 pounds.

Table I gives the summary of sludge drying beds operation since they were built.

TABLE I—SUMMARY OF SLUDGE DRYING BEDS OPERATION

Month and Year	Average Temp.	Total Prec.	Number Filled	Number Cleaned	Moisture % Filled	Moisture % Cleaned	Depth Filled, Ins.	Depth Cleaned, Ins.	Drying Time in Days	Tons Dry Removed
Dec., 1930.....	51.0	.88	8	5	97.43	83.2	9.0	4.0	18.4	7.6
Jan., 1931.....	52.6	5.86	8	3	95.99	79.5	9.0	4.0	30.0	4.6
Feb., 1931.....	57.4	2.68	3	5	95.15	79.7	9.0	4.0	33.0	6.8
March, 1931.....	58.0	2.06	8	6	97.03	61.2	9.0	4.0	15.8	20.4
April, 1931.....	64.2	2.28	20	32	95.05	71.0	9.0	4.0	13.6	78.0
May, 1931.....	72.5	1.36	35	30	96.21	72.4	9.0	4.0	14.8	64.2
June, 1931.....	81.2	3.10	37	25	91.12	63.3	9.0	4.0	11.0	72.6
July, 1931.....	82.6	3.09	54	37	95.93	68.1	9.0	4.0	14.0	109.7
Aug., 1931.....	82.0	.30	53	46	96.28	48.1	9.0	4.0	15.7	112.0
Sept., 1931.....	83.2	.01	73	81	96.55	37.8	9.0	4.0	14.3	174.5
Oct., 1931.....	78.0	.75	66	58	96.73	53.6	10.0	4.5	13.7	127.0
Nov., 1931.....	66.6	.72	47	49	96.70	51.6	10.1	4.0	21.2	103.7
Dec., 1931.....	55.2	2.79	17	14	96.69	59.2	9.8	4.6	47.7	27.3
Jan., 1932.....	55.4	3.30	22	27	96.72	64.4	11.4	4.5	53.2	52.2
Feb., 1932.....	63.0	1.86	37	35	96.28	65.8	9.9	4.2	33.3	65.5
March, 1932.....	57.4	1.05	10	18	96.00	45.1	6.2	4.5	34.2	38.9
April, 1932.....	70.4	2.61	2	6	95.83	10.2	4.5	2.0	47.3	12.0
May, 1932.....	75.4	2.10	15	15	95.18	10.5	5.6	1.5	90.6	38.7
June, 1932.....	82.2	1.94	14	35	95.80	12.7	7.1	2.5	29.8	60.0
Averages	67.9	2.35	27.8	27.7	96.00	54.5	8.7	3.8	29.0	62.0



View of Sludge Beds, Looking East. Note Truck on Plank Runway Being Loaded

Construction Costs

The construction cost of the sludge drying beds can be divided as follows:

Labor	$19,388.86
Gravel and sand	6,322.49
Lumber	4,026.96
Drain tile	620.95
Sludge pipe line	833.43
Gasoline for excavator	378.75
Repairs to excavator	94.78
Gravel for roadway	568.00
Tools and miscellaneous	651.74
Total	$32,885.96
Total area in square feet	84,000
Total cost per acre	$16,988.40
Total cost per square foot	.39

The above includes cost of excavation and leveling of the existing sludge lagoons, also cost of garage and

San Antonio Sewage Plant. Sludge Going on Drying Bed. Note Splash Board and Trough

tool house. All work has been done under city supervision and with city forces.

Operating Costs

The cost of operation may be shown as follows:

Amortization and interest	$4,690.00
General maintenance	525.00
Sand replacement	811.00
Total	$6,026.00
Cost per ton (dry basis)	$6.94

No figure for the cleaning of beds is given, as the dried sludge is taken away by farmers, furnishing their own trucks and labor for removing of sludge from drying beds. Under prevailing conditions in San Antonio, the cost of removal from sludge drying beds would amount approximately to $2.50 per ton, dry basis, if done by city labor. To date the demand for dried sludge is such that it is removed by takers as fast as it dries.

The analysis of dried digested sludge, as removed from sludge drying beds and calculated on dry basis is as follows:

Nitrogen, 2.55 per cent.

Total Phosphoric Acid, 1.35 per cent.

Insoluble Phosphoric Acid, 0.26 per cent.

During April and May, 1932, experiments were conducted on grinding the dried digested sludge. For this purpose a small hammer mill with dust collector was used. This mill was driven by a 15 h.p. motor. It was possible to grind two tons of sludge per eight hour day. The cost of installation was $400, including grinder, dust collector, motor and a 440 volt power line approximately 400 feet long.

The ground sludge could be disposed of for $10.00 per ton, but owing to the difficulty of obtaining dry enough sludge for grinding, it was decided to abandon the scheme for the present.

Operating expenses of the grinder, per ton of material produced, were as follows:

Depreciation and interest	$ .10
Power	.50
Labor	2.50
Sacks	1.40
Total	$4.50

Studies on mechanical filtration of sludge will be undertaken shortly to determine the feasibility of such procedure.

[NOTE: In a near future issue of WATER WORKS AND SEWERAGE there will appear an article covering the cost of dewatering and drying sludge at eight important and representative sewage treatment plants in America.—EDITOR.]

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K. M. BROWN HEADS AMERICAN WELL DRILLERS.—K. M. Brown, of Fairmont, Minn., was elected president of the American Association of Water Well Drillers at the convention at Lincoln. Other officers are: Vice-president, H. H. Brown, Blair, Neb.; Treasurer, L. J. Faust, Kaukauna, Wis.; Secretary, R. O. Monroe, South Bend, Ind.; Secretary of committees, P. W. Thorpe, Des Moines, Ia. The associations of twelve states have membership in the national organization.

FILTRATION PLANTS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. BAYLIS, Associate Editor

Physical Chemist, Bureau of Engineering, Chicago, Ill.

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TURBIDITY DETERMINATIONS

DETERMINATION of the turbidity of the water is probably the most important test in the operation of filtration plants. The frequency with which it should be made on many waters makes it desirable to have means of testing which require as little labor as possible. Satisfactory methods of making turbidity measurements on waters of high to fairly low turbidities have been in use for more than 30 years. These methods, however, did not enable one to determine the turbidity of the filtered water with the accuracy essential for good filter plant operation, and it was not until 1923 that means of accurately determining very low turbidities became available. Since that time several instruments for making low turbidity readings have been developed.

The main purpose of this article is to describe the instruments for measurement of low turbidities, but in addition a review of the development of turbidity measurements will be given. The origin of a test so important to filtration as the turbidity test should not be forgotten, consequently a brief history of its development is given for the benefit of those who have not been engaged in water treatment for a considerable number of years. Many methods of making turbidity tests have been suggested, but this article will be limited largely to devices which have been used to a certain extent in water analysis.

Development of Methods for Making Turbidity Determinations.—The first method of expressing turbidity was in words such as "very slight," "slight," "distinct," and "decided." George Hornung[1] used a diaphanometer for measuring the turbidity of the Ohio River water at Newport, Ky., from 1876 to 1896. It was about 1889 that the Experimental Station of the Massachusetts State Board of Health at Lawrence[2] began to give consideration to more exact methods of expressing turbidity. The very simple device of sticking a pin into a stick of wood and pushing it down into the water as far as it could be seen was used. This method is said to have been used in Europe a number of years prior to its use in America. Later a platinum wire 1 mm. in diameter was substituted for the pin, and the rod was graduated so that the turbidity was ready directly.

The scale used at first for the platinum wire method was not a very good one. When the depth at which the wire became invisible was 1 in. below the surface of the water the turbidity was recorded 1.0. When the depth was 2 in. below the surface the turbidity was 0.5, and when it was 10 in. the turbidity was 0.1. The platinum wire method of turbidity determination later became the basis of all turbidity measurements in this country, but the turbidity scale was changed.

The diaphanometer attracted some attention prior to 1900. The improved instrument was described by Parmelee and Ellms[3] in 1899. It is a tube with a transparent diaphragm at the lower end. Light is reflected up through the tube, and the water is admitted until an image painted on the diaphragm just disappears. The reciprocal of the depth in inches is taken as the turbidity reading, and corresponds in a general way to the readings of the wire method.

Photometric methods were used to a limited extent prior to 1900. Such an instrument was used by James Seddon[4] at St. Louis in 1889. Parmelee and Ellms[3], in 1899, described the instrument used by Seddon. Real progress in making turbidity determinations was not made until after a standard of turbidity was adopted shortly after 1900.

Standards for Turbidity Measurements.—Mason[5] was the first to suggest the use of a standard suspension for making turbidity tests. The standard suspension was made by adding one gram of exceedingly fine kaolin (obtained by eleutriation) to one liter of distilled water.

Whipple and Jackson[6] improved the method by substituting finely powdered diatomaceous earth for the kaolin. They stated that the standards of kaolin could not be readily duplicated. The diatomaceous earth was washed and ignited, treated with hydrochloric acid (1:1) and washed with distilled water. After drying at 100° C. it was ground in an agate mortar to a very fine powder. A stock mixture was made by adding 1 gram of the powder to 1 liter of distilled water. Five standards were made as follows:

Silica standard	0	5	10	15	20
Stock mixture to add to distilled water to make 3 liters—cc	0	15	30	45	60

Later Whipple and Jackson[7] compared the various methods of measuring turbidity and found fairly close relation between the wire method, the diaphanometer method, and silica standards.

The Committee on Standard Methods of water Analysis of the American Public Health Association[8] in its first report in 1900, gave consideration to the measurement of turbidity in water:

"At the present time there is no uniformity in the methods of measuring turbidity or suspended matter. The wire method, the disc method, the diaphanometer method, the gravimetric method, and the use of standards of comparison all appear to have their field of usefulness. It is desirable that some system should be adopted for making the results by the various methods comparable, at least for those lines of work of the same general nature. In the absence of the necessary experimental data, your committee is unable to make a definite

recommendation at present, although studies now in hand will probably make this possible another year."

In the second progress report of the Committee on Standard Methods[9] in 1901, the committee recommended that the standard unit of turbidity be considered as that produced by one part per million of silica in distilled water, that the results of turbidity be expressed in parts per million of silica, and that the results obtained by the wire method and the diaphanometer method be reduced to their equivalents in parts per million of silica for purpose of report. This was the first definite turbidity standard adopted in America. It established the turbidity unit, but it did not definitely establish the scale on instruments used for making turbidity measurements.

The standard adopted by the United States Geological Survey[10], which was recommended by Hazen and Whipple, fixed the turbidity scale for the platinum wire method. As the adoption of the platinum wire scale by the U. S. Geological Survey set a definite scale for turbidity measurements, and all future measurements have been based upon this scale, quotation from the original article will be given:

"The standard of turbidity shall be a water containing 100 parts of silica per million in such a state of fineness that a bright platinum wire 1 millimeter in diameter can just be seen when the center of the wire is 100 millimeters below the surface of the water and the eye of the observer is 1.2 meters above the wire the observation being made in the middle of the day, in open air, but not in sunlight, and in a vessel so large that the sides do not shut out the light so as to influence the results. The turbidity of such water shall be 100."

"The turbidity of the water more turbid than the standard shall be computed as follows: The ratio of the turbidity of the water to 100 shall be as the extended volume is to the original volume, when the water is diluted with a clear water until the mixture is of standard turbidity."

"The turbidities of water lower than the standard shall be computed as follows: The ratio of the turbidity of the water to 100 shall be as the ratio of the original volume of standard turbidity is to the extended volume when such water is diluted with clear water until its turbidity is equal to that of the water under examination."

A table for the vanishing depths of the wire also was given. This rod was known as the United States Geological Survey turbidity rod of 1902. The scale had a range of turbidity from 7 to 3,000. The circular stated that when the turbidity was greater than 500 the water should be diluted before observation is made. When the turbidity is below 7 comparison with silica standards should be made. This scale, without change, has been used up to the present time, though a turbidity measurement is seldom made with the turbidity rod. The platinum wire turbidity rod with the scale as described became the basis for fixing the scales on all other turbidity instruments, and while it probably will always be the basis of turbidity measurements in America it has been replaced by more convenient methods of determining the turbidity.

The Jackson Candle Turbidimeter.—The most convenient instrument for measuring turbidities was devised about 1900 or 1901 by Daniel D. Jackson, Chemist in Charge of the Mount Prospect Laboratory, Department of Water Supply, Gas and Electricity, City of New York. The first mention of this instrument by Jackson[11], which the writer has found, was in 1901. The article was on the determination of sulfates in water by the turbidity method and did not state that the instrument was for use in determining the turbidity of water in general, but very likely it was used by Jackson for this purpose. A photograph and description of the Jackson candle turbidimeter was given by Leighton[12] in 1905. Apparently the instrument was at first intended for turbidities above 100, as this was as low as the scale was shown in the table given in the second and third editions of Standard Methods of Water Analysis.

The Jackson candle turbidimeter has undergone practically no change since it was first developed, for the instrument illustrated by Leighton in 1905 is practically the same as is being manufactured today, except that a longer glass tube for reading to turbidities as low as 25 has also been in use for a number of years. The instrument is illustrated in Fig. 1 and as it is described in Standard Methods, there is no need for further description.

Even though the scale of turbidities on the glass tubes are based upon the U. S. Geological Survey rod of 1902, the Jackson candle turbidimeter has become the standard for turbidity measurements in America through common use. Silica standards are no longer prepared from definite weights of fuller's earth. Some amount of the earth is added to distilled water, the coarser material allowed to settle, the supernatant liquid decanted or siphoned off, and the turbidity determined with the candle turbidimeter. Instruments for the measurement of low turbidities also are standardized by the Jackson turbidimeter, thus it becomes the only standard for turbidity measurements at the present time. A turbidity of 100 determined by the candle turbidimeter is approximately 100 parts per million of suspended matter, but the actual

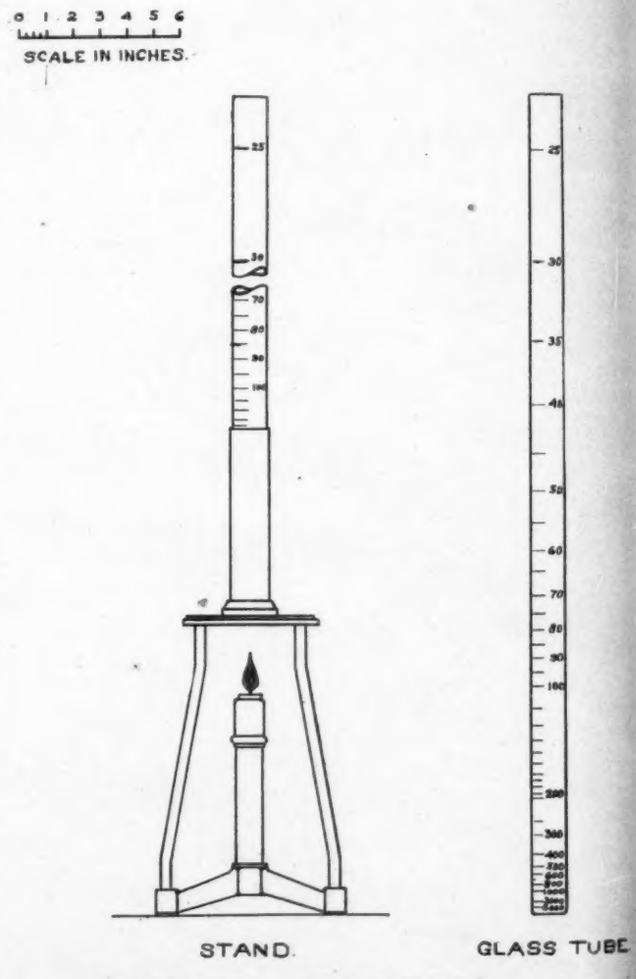

Fig. 1—Jackson Candle Turbidimeter

weight of the suspended material may vary from this amount.

It has been stated that all instruments for the measurement of low turbidities in this country are based upon the turbidity determined by the candle turbidimeter. The tests are made either by comparing with standards which are prepared by diluting a suspension of known turbidity with zero turbidity water, or by some instrument with a scale which has been determined by the standards. Almost invariably the turbidity of the known suspension is determined with the candle turbidimeter.

The Baylis Turbidimeter.—The writer[13], in 1923, devised an instrument for the accurate measurement of low turbidities. This is believed to be the first practical instrument for the estimation of very low turbidities, such as the turbidity of filtered water. Details of the instrument are shown in Fig. 2. It is primarily for water of very low turbidity, the range being from 0.0 to 2.0 turbidity. If higher turbidities are to be determined, the water has to be diluted with zero turbidity water. The instrument has been described in several articles by the writer[14].

The instrument consists of two glass tubes, 30 in. long, with flat polished bottoms, and a 200 or 250 watt lamp located about 30 in. to the side of the tubes. The light beneath the tubes passes through a blue cobalt glass, and when there is no matter in suspension in the water one sees, in looking through the tubes, a perfectly blue field. A white opal glass is placed beneath the tubes to reflect the blue light. When there is matter in suspension in the water the particles are illuminated from the light on the side, and this cuts out some of the blue light which one would see in looking through the tubes. Practically no blue light can be detected when the turbidity is 2.0, consequently readings cannot be made on higher turbidities. If the sample is higher in turbidity it may be diluted below 2.0 and the determination made, unless it is more convenient to use some other kind of turbidimeter. The reading is made by comparing with standards of known turbidity prepared from fuller's earth.

Preparation of Standards for the Baylis Turbidimeter.—The following is a digest of the procedure prepared by the writer for inclusion in the seventh edition of Standard Methods of Water Analysis:

Add 2 or 3 grams of fuller's earth to about 1 liter of distilled water, thoroughly agitate several times within a period of one hour, and then allow to stand about 24 hours. Withdraw part of the supernatant liquid without disturbing the sediment on the bottom, and test the turbidity with the Jackson candle turbidimeter. If the turbidity is less than 25, add more of the earth and repeat the procedure.

Dilute portions of the stock solution to the desired standards with zero-turbidity distilled water. For turbidity readings between 0.0 and 2.0, standards of 0.1, 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, and 2.0 should be prepared. The quantity of stock solution required to prepare a certain standard is the volume of the standard multiplied by the desired turbidity and this divided by the turbidity of the stock solution. If the stock solution has a turbidity of 30 and it is desired to prepare 500 ml. of 0.6 turbidity (500×0.6) divided by 30 gives 10 ml. of the stock solution.

Procedure for Making Turbidity Measurements With the Baylis Turbidimeter.—Fill one of the long glass tubes with the water to be tested. Allow to stand until all the air bubbles have disappeared, which is usually about 5 minutes. This may be hastened by applying suction to the tube. Observe the sample before filling the other tube with a standard of known turbidity and make a guess at the turbidity. Use the standard nearest

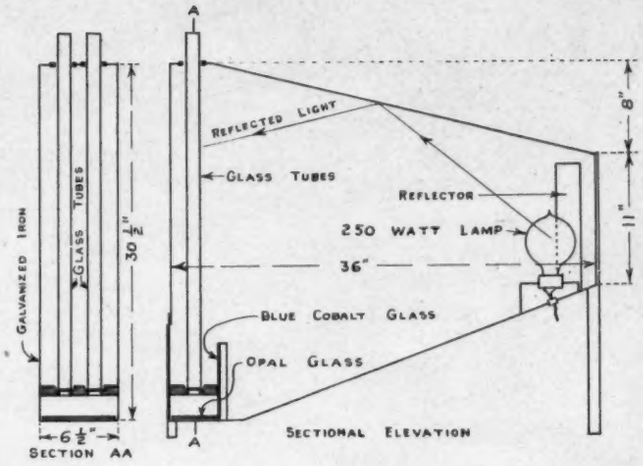

Fig. 2—Baylis Turbidimeter

the guess and make a comparison. If the standards are kept in the long tubes, tilt two or three times to thoroughly mix the suspended matter with the water. It is believed best not to keep the standards in the long tubes all the time. They should be emptied into flasks when the turbidity readings for the day have been completed. Vigorous agitation of the flasks before the water is poured into the long tubes helps to keep the suspended matter broken up into very fine particles. If the sample varies from the standard, use another standard and continue until the one nearest to the sample is found. Keep the glass tubes filled with water above the line where the light strikes the tube; otherwise corrosion of the glass at the water line may interfere with the results. The glass tubes should be kept clean on both the inside and outside. Do not handle the tubes below the line where the light strikes them.

The St. Louis Turbidimeter.—Another instrument capable of making low turbidity readings was devised by Graf and Nolte[15], of the St. Louis, Mo., water works (see Fig. 3). The following description of the instrument is given in the American Journal of Public Health:

"The entire box, except the partition, is constructed of wood and painted black, both inside and outside. The partition of galvanized sheet metal is also painted black. All inside measurements of the box and parts should be made exactly as indicated because the dimensions locating the normal position of the light filament, the light aperture in the partition and the circular openings in the shelf are important."

"The position of the light aperture and the openings are fixed but that of the light filament is adjustable. This was made so to take care of slight variations in the shape and position of the filament in the lamp. The filament may be moved to or farther from the partition by adjusting the metal contact in the light socket; and shifting from side to side by means of the sliding block which carries the lamp. The position of the filament from top to bottom is fixed; the open end should point up. The position need be fixed but once for each lamp."

"The tubes for making the turbidity determinations should be clear glass, 100 cc., short form Nessler tubes, free from scratches or other imperfections. These should be scrupulously clean at all times. Fresh standards should be prepared from a stock suspension, the turbidity of which should be 10 p.p.m., so that when 1cc. of the suspension is made up to 100 with turbidity free distilled water, a standard containing 0.1 p.p.m. will be obtained. The suspension containing 100 p.p.m. can be made from one containing enough turbidity to be determined by the Jackson candle turbidimeter and diluted

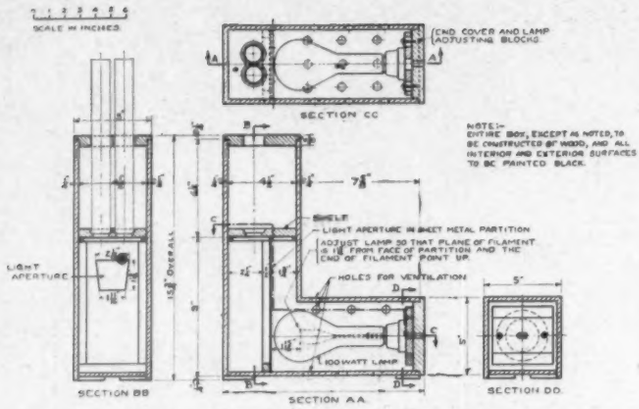
SCALE IN INCHES
END COVER AND LAMP ADJUSTING BLOCKS
SECTION CC
NOTE:- ENTIRE BOX, EXCEPT AS NOTED, TO BE CONSTRUCTED OF WOOD, AND ALL INTERIOR AND EXTERIOR SURFACES TO BE PAINTED BLACK.
SHELF
LIGHT APERTURE IN SHEET METAL PARTITION
ADJUST LAMP SO THAT PLANE OF FILAMENT IS 1/8" FROM FACE OF PARTITION AND THE END OF FILAMENT POINT UP.
LIGHT APERTURE
HOLES FOR VENTILATION
100 WATT LAMP
SECTION BB
SECTION AA
SECTION DD

Fig. 3—Saint Louis Turbidimeter

to yield the desired standard stock suspension. . . ."

One hundred cubic centimeters of the sample to be tested are placed in one Nessler tube, and is compared with standards of known turbidity. The device has a wider range of turbidity measurements than the Baylis instrument, and as a result is less sensitive to slight variations in the turbidity. It is reported to be sufficiently accurate for making low turbidity readings.

The Patterson Turbidimeter.—One of the most convenient instruments for measuring turbidities between about 0.5 and 10 is the Patterson turbidimeter, manufactured by the Patterson Filter Company of England. Turbidities as low as 0.3 may be read fairly accurately, but like the St. Louis instrument it loses some sensitiveness in the lower ranges due to covering such a wide range.

The Patterson instrument, shown in Fig. 4, is a rectangular metal box which holds two liters of water. A mirror is set on each side of the box with the faces exactly parallel to each other. A small 8-volt light is fastened to the outside of the box where there is a small opening through the metal and the coating on the glass which produces the mirror. On the opposite side of the box is a similar hole for observation. The holes are not exactly opposite each other, and images of the light reflected by the mirrors may be seen. It is somewhat like standing in the center of a "white way" street and looking at the line of lights down one side. Each succeeding light is a little farther away and a little less brighter. Turbidity in the water cuts out some of the images.

There is a sliding diaphragm fastened to the cover of the box. The cover has a long slot so that the diaphragm may be moved most of the distance across the box. The diaphragm is made so as to cut out any further reflections, and is for the purpose of locating the last light just visible. A pointer on the slide gives the turbidity, which is marked on the cover along the side of the slot. The English turbidity scale apparently is not the same as that used in this country, for standard turbidities prepared as given in a previous paragraph do not check exactly with the scale on the instrument. It takes only a short time to prepare a correct scale and paste over the scale on the instrument.

The advantage of the Patterson turbidimeter is that no standards are required for turbidity readings. Dilutions for higher turbidities are easy to make, though it is believed best not to test turbidities above 25, as this is within the range of the candle turbidimeter. The labor involved in making a turbidity reading is less than that of the Jackson turbidimeter, or any of the other instruments which have been mentioned. It is hoped that the Patterson turbidimeter will soon be offered for sale in this country, for it is very convenient for making turbidity readings between 1.0 and 10.0.

It is hoped that these remarks will give a fairly complete history of the development of turbidity measurements and the standard of turbidity in use in this country. It also is hoped that the description of the instruments for making low turbidity readings will enable one to select the one most suited for their needs. The writer may add here that he has no interest whatever in the sale of the instrument bearing his name, and has never received any compensation or royalty from the Levitt-Ferguson Company of Baltimore, Md., who manufacture the instrument.

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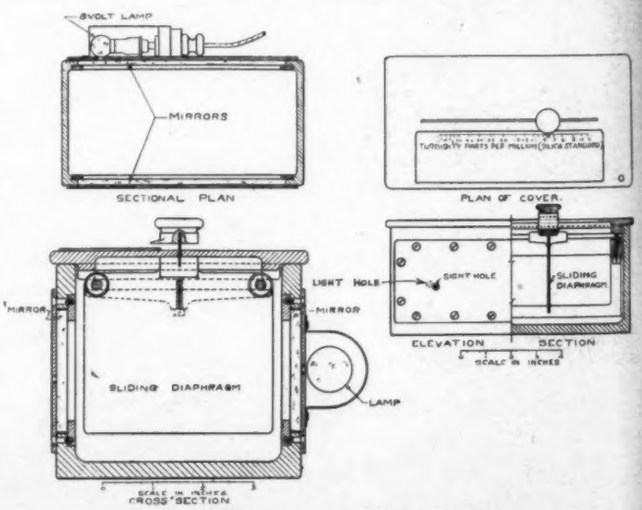


Fig. 4—Patterson Turbidity Meter

MEETING OF THE NEW JERSEY SEWAGE WORKS ASSOCIATOIN

THE New Jersey Sewage Works Association held its 19th annual meeting in Trenton, N. J., at the Hotel Hildebrecht, the attendance this year being somewhat greater than that of 1932. The registration was 180 with an estimated 200 attending. The now famous annual "Speechless Dinner" was the usual success, with P. N. Daniels as No. 1 man in charge of entertainment and meeting arrangements.

Following the meeting a group visited the new sewage treatment works of Princeton, N. J., over which the Vice President of the Association, I. R. Riker, has charge.

Election returns showed the following selections for officers during the ensuing year.

President—Courtland H. Shute of Glassboro, N. J. (Reelected.)

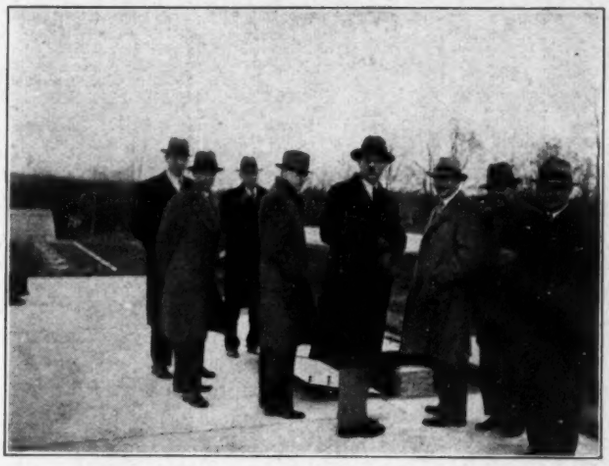
Vice President—W. C. Mallalieu of Boonton, N. J. (Reelected.)

Vice President—I. R. Riker of Princeton, N. J.

Treasurer—E. P Mollitor of Springfield, N. J. (Reelected.)

Secretary—John R. Downes of Bound Brook, N. J. (Reelected.)

Assistant Secretary-Treasurer—Paul Mollitor, Jr., of Morristown, N. J.



Group of Visitors Being Shown Around the Purification Plant by Messrs. Riker and Curry. George D. Norcom Knows All About Water Purification and He's Not Missing the Opportunity to Keep Abreast of Sewerage Developments. George Is in the Front Center of the Group.

Technical Sessions

Several of the papers read dealt with chemical phases of sewage treatment. L. L. HEDGEPETH, Research Engineer, Pennsylvania Salt Mfg. Co., in an excellent presentation of the "Modern Developments in Chemical Precipitation" brought together into one paper brief descriptions of the several processes under development in which chemical treatment is involved.

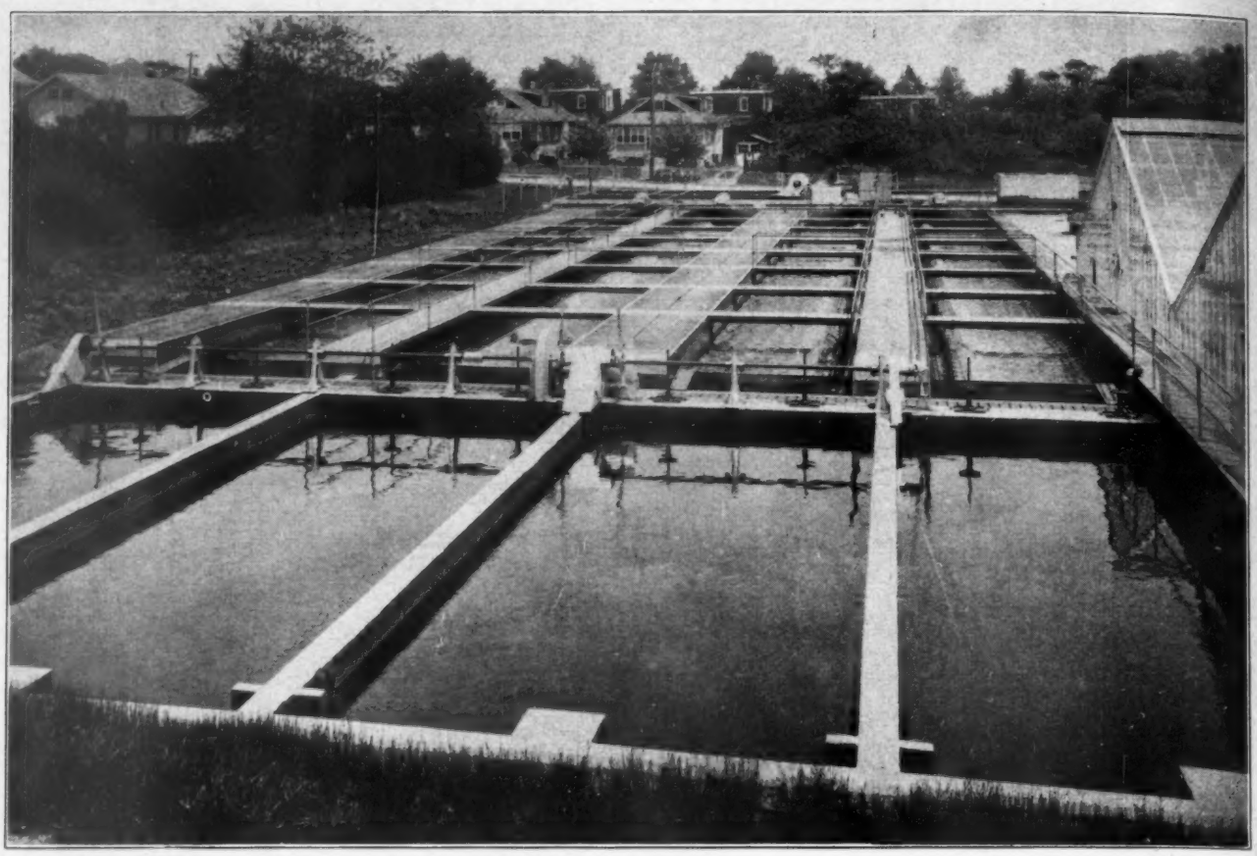
JOHN R. DOWNES, Supervising Engineer, Plainfield Sewage Works, disclosed results attainable with ferric iron coagulation of sewage which renders the process of partial chemical precipitation economically attractive as a treatment preliminary to biological purification. With comparatively low dosages of the coagulant the oxygen demand loading applied to sprinkling filters, he found, could be reduced by 50 per cent, provided efficient mixing and flocculation be given. The sludge question did not seem to give Mr. Downes concern. He had found very little additional *volume* of sludge resulted because of the increased sludge density procured in the process as evolved. Furthermore, he had no fear as to the digestibility of the sludge because he had noted no effects from the iron other than beneficial ones.

John R. Downes, Superintendent Sewage Works, Plainfield, N. J., Has Served as Secretary of the New Jersey Sewerage Works Association for 18 Years

In brief, the Plainfield scheme involves the application of 200 pounds of a commercial ferric sulphate per million gallons of sewage—the point of application being to the sprinkling filter discharge as it enters the final tanks. All sludge produced is pumped to the incoming crude sewage and along with this sludge is added additional ferric coagulant. Vigorous agitation followed by 8 to 10 minutes of gentle flocculation is given the mixture. The coagulant added is varied to meet requirements, i. e., with change in quality and quantity of sewage received at the works. To the night flow no added coagulant will be required, the sludge being sufficient. The maximum rate of ferric sulphate requirement for day flows is 400 pounds of "Calcoag" (75 per cent $FeSO_4$) per m.g., and the average consumption of chemical will amount to 250 pounds per million gallons of crude sewage received. Mr. Downes believes, possibly less. The final plant effluent will be sparkling and have a two-day oxygen demand of negligible values—3 parts being the minimum observed. Mr. Downes said that odors from sludge digestion were lessened and the acid stage of digestion was apparently missing when ferric coagulation was involved. He believed the scheme of reducing filter loadings by utilizing partial precipitation with chemicals to be more practical than the less dependable partial activation schemes tried with varying degrees of success at Plainfield and elsewhere. The iron scheme, he said, would be controllable and immediate.

Mr. Downes' paper, **"Chemical Treatment of Sewage in Connection with the Operation of Sprinkling Filters,"** will appear in condensed form in the May issue of WATER WORKS AND SEWERAGE.

WELLINGTON DONALDSON of Fuller and McClintock, Engineers, who has been working with Mr. Downes on the Plainfield problem, said that complete chemical precipitation had required far too great dosages of chemicals at Plainfield and that the partial treatment had come about as a result. The visible improvement had been misleading so far as the effluent from the primary treatment was concerned, but the appreciable reduction of the loading on the filters as disclosed by the 50 per cent oxygen demand reduction was inescapable and had constituted a real surprise to all concerned. Mr. Donaldson quoted figures from the Palo Alto, Calif., work which indicated that 200 pounds of ferric chloride per



Sewage Treatment Plant, Collingswood, N. J., Looking from the Final Clarifiers Across the Aerators and Primary Clarifiers Beyond. Note Closeness of Plant to Residences Which Necessitates Prechlorination for Odor Prevention in Summer.

million of sewage was effective there when used in combination with the returned chemical sludge to the crude sewage. [In the Palo Alto scheme a two stage precipitation is involved—the first being with the return of chemical sludge alone—and the second with ferric-chloride. See WATER WORKS AND SEWAGE for March, 1933, in which appears an article by R. A. Stevenson disclosing recent simplification of the stage process developed at Palo Alto.—Editor]

An Operation Paper of Excellence

Among the papers on plant operation, that by C. W. DARE, Superintendent of Water Works and Sewerage at Collingswood, N. J., was outstanding.

In recounting operating experiences at the Collingswood activated sludge plant, employing mechanical aeration provided by Link Belt "Straight Line" aerators, Mr. Dare said that by experimentation they had worked out an automatic "on and off" scheme of aerator operation which had reduced the power requirement by about one-third. As explained to this writer, a program clock throws the aerator motors into operation and off again at desired intervals—the present scheme being ten minutes of aeration and five minutes of rest in each complete cycle, the operation being continuously repeated during the 24 hours. As one aerator starts up, another goes out in rotation, all of which is an ingenious scheme and together with other operating economies has reduced the 1932 cost of operating the plant, treating domestic sewage of 850,000 g.p.d. average flow, to $50.57 per m.g. treated ($1.22 per capita) as against a figure of $61.79 for 1931. The rate for power at Collingswood is only 0.6 cents per k.w.h. which, Mr. Dare explained, was allowed because of their program of doing all operations requiring power at night as far as possible—sludge pumping in particular.

Charles W. Dare, Superintendent Water and Sewerage, Collingswood, N. J.

The four straight line aerator mechanisms are operated by four 10 h.p. motors, the average retention in the aerators being 6 hours. Sludge return, Mr. Dare said, was carefully watched to maintain 20 per cent by volume (1-hour cylinder settling test conducted every 2 hours during the 24) because experience had shown that control to be highly important to efficient operation. As much as 30 per cent sludge in the aerators would give trouble and loss of floc in the effluent. Surplus sludge could not be run directly into the separate digestion tanks of shallow (10 ft.) construction because of the large volume per day (150,000 gals.) which upset the digester and prevented separation of supernatant liquor. Considerable improvement had followed the practice of adding the surplus sludge to the crude sewage during the night flow. Mixture of crude and activated sludge transferred nightly to the digesters had averaged but 30,000 gals., representing about the maximum that could be admitted daily to the digesters. Supernatant liquor (discharged to the crude sewage) has been found to be of best quality about 3 ft. below the surface, at which point the adjustable draught tube is set. The digesting sludge is maintained at pH 7 to 7.3 by lime applied as required (usually 50 lbs. per day) to the sludge pumped in. The digesters are baffled to give a 125 ft. travel

through, and are hot water coil heated to maintain a temperature of 74° F. or above. Sludge gas is used for such heating. Sludge, drawn every three weeks to a depth of 10 inches on glass covered beds, averaging 3 per cent solids (42 per cent ash), can be removed after two weeks of drying. Much of it is passed through a shredder and sold locally for lawns and flower gardens at $2.50 per load of 1.5 cu. yd.

The primary settling tanks designed for a 2 m.g.d. flow had proven of too great volume for operation in parallel and therefore one is now used at a time with resulting diminution of odors and pre-chlorine dosage used for odor control. The average of 850,000 gal. per day flow through one tank (1 hour and 10 minutes average theoretical detention) results in a 50 per cent removal of suspended solids, whereas the two in parallel had removed 75 per cent. In addition to the 5 p.p.m. prechlorination dosage used in summer for odor control, without deleterious effect on the activation, the final effluent had been continuously chlorinated—and fortunately so, perhaps, because they had found it necessary to put up a sign at a small fountain fed by plant effluent in order to stop passers-by from drinking there. The final chlorination, Mr. Dare said, had reduced the oxygen demand of the effluent to 7 p.p.m. from a figure of 21 parts. The fine solids leaving the final tanks to the extent of 45 p.p.m. average turbidity probably accounted for the relatively high oxygen demand of the unchlorinated effluent.

Cost Data for Year 1932

Maintenance of plant and grounds	$ 1,181.00
Gasoline for crude sewage pumping	864.00
Insurance	223.40
(a) Power at treatment works at 6c per k.w.h.	3,960.10
(b) Power at sub-pumping station at 6c per k.w.h.	1,445.35
Operators' wages	7,200.00
Materials and supplies	715.15
Repairs, machinery and tools	522.15
Chlorine	676.00
Total cost of operations	$16,587.85
Total cost per m.g.	*505.57
Total cost per capita	1.22

*A reduction from $61.79 per m. g. in 1931.

In discussion, Mr. Dare said that experiments with sludge dewatering by centrifugal methods was under way at Collingswood and held some promise of success.

"Operation of the New Sewage Treatment Plant at Princeton, N. J., by I. R. Riker, Supervising Engineer of the Princeton, N. J., Sewerage System.

The Princeton plant having just been described in the March issue of Water Works and Sewerage, Mr. Riker said he would confine his remarks to operating results obtained. Mr. Riker said that the plant employing pre-chlorination, separate sludge digestion, sprinkling filters and post-chlorination and, designed for 2 m.g.d. was now treating an average of 1.2 m.g.d. flow of domestic sewage rather high in content of kitchen greases. The designed filter loading was 300,000 gals. per acre per day per foot of depth and the filters had been designed for flooding to control the filter fly.

The operating results during January and February had shown 65 per cent suspended solids removal and a 41 per cent b.o.d reduction through the primary settling tanks (no mechanism for sludge removal) and an overall reduction of 72 per cent by the plant. The nitrification by the filters, he said, had begun during the first month of operation, reaching 7 p.p.m. nitrate nitrogen, thereafter gradually increasing to 14 p.p.m. notwithstanding the residual chlorine present in the applied sewage and an almost sterile filter affluent. Subsequently they had

Princeton's New Sewage Treatment Plant. Beyond the Filters: To Left, Sludge Beds; Center, Control House and Chlorinating Station; To Right, Digestion Tanks.

reduced the chlorine dosage to the crude sewage and instead of carrying residual chlorine had with the assistance of Mr. Griffin of the Wallace & Tiernan Co. made use of the relative stability test as a pre-chlorination control measure. In this scheme just enough chlorine is added to cause the methylene blue color to hold in the samples for 2 hours as the minimum. The lack of fading out of the color during a period of between 2 and 12 hours was sufficient for odor control—up to date at least. The test seemed to be an excellent indicator without the necessity of insuring the complete satisfaction of the very variable chlorine demand of the crude sewage (3 to 12.5 p.p.m.) depending upon the time of day when samples were collected.

I. R. Riker, Engineer in Charge of Construction of the Princeton Plant and Now Supervising Engineer of Operation

The filter effluent had been fairly turbid but had only exhibited a chlorine demand averaging 2 p.p.m. in recent weeks—being 1 p.p.m. at night and reaching a maximum of 3 during the heavy flow hours. Goldfish were being maintained in the effluent containing 0.1 p.p.m. residual chlorine after the two hour contact period in the final settling tanks. They had made a practice of varying the chlorine dosage to both crude and filter effluent to meet the changing demands of each. Final effluent had proved satisfactory for operating the W. & T. vacuum type chlorinator injectors.

Mr. Riker said that the multiple discharge effluent outlet into the river was a great thing because the plant effluent did not show at any point. Analysis had shown the river 300 ft. below the outlet to be no different from the quality above the plant. If anything, it was improved bacterially.

From the digesters it was necessary to draw 5,000 gals. of supernatant liquid per day for addition gradually to the crude sewage and sludge, pumped weekly from the final tanks, was also discharged into the crude sewage. To improve the appearance of the final effluent chemical precipitation such as that used at Plainfield would most likely be resorted to.

Citing costs of operation during January and February, the cost including pumping at $10.00 per m.g. (a 70 ft. lift) had averaged $32.00 per m.g. The costs

could be broken down as follows: supervision and laboratory, 20 per cent; pumping, 44 per cent; operating tanks and filters, 14 per cent; chemicals, 13 per cent; care of grounds, 6 per cent; and 3 per cent miscellaneous. The power rate for pumping being so high (2.1 ct. per k.w.h.) there was some probability that the stand by Buffalo gasoline engine generator set would be operated to provide current for the pumps and treatment plant.

In reply to questions, Mr. Riker said that there was a great deal of local interest in the new plant. School children had been his best publicity agents. The operating personnel consisted of 2 operators, 2 laborers and himself in charge. Operators on duty for 12 to 16 hours had proven sufficient.

Moving pictures showing the plant under construction were shown.

"Operation of the Freehold Plant," by W. J. SCHIVEREA, Superintendent of Sewerage, Freehold, N. J.

Mr. Schiverea recounted difficulties met with due to industrial wastes from a rug mill emptying into the sewer. High concentration of dye interspersed with strong hypochlorite bleach had prevented the sprinkling filters from properly functioning.

Sewage is now largely domestic, is strong and stale to septic, requiring pre-chlorination to control odors. A dosage of 10 p.p.m. chlorine at the dosing tank during low flows had removed slime from the filter stone and reduced the fly nuisance very materially. A final dosage of chlorine added to the inlet of the final settling tank maintained residuals of 0.2 to 0.4 p.p.m. in the effluent and B.O.D. values averaging 30 p.p.m.

Sludge from the primary clarifiers is pumped 3 times daily to the digesters—the Dorr sludge mechanism being operated for 20 minutes during the pumping period and the index of when to stop pumping is found in sampling. When the settleable solids drop below 50 per cent by volume pumping is stopped. Final tank sludge is pumped direct to the digester. Gas collected heats the digester, 33 per cent of the total gas produced being so used. The stirring mechanism has proven valuable at Freehold and sludge drawn contains 95 per cent water and dries in two to three weeks. Supernatant liquor is run onto sand beds.

Cost of operating the plant in 1932 was $6,693 for the 350,000 g.p.d. average flow. Of this $1,731 went for power, the cost being $53.00 per m.g. for treatment. One operator, an assistant and one laborer operate the plant.

The Effect of Septicity on Sewage Treatment

In a **"Comparison of Treatment of Fresh and Stale Sewages,"** DR. RUDOLFS brought forward some highly interesting observations concerning the deleterious effects of septic action in sewer systems and pump wells and the added expense and difficulties of treatment which resulted from the effects produced by septic action or changes in the sewage created by bacterial action. The latter, he said, brought about disintegration of suspended solids, resulting in their change to non-settleable materials. Due to splitting up of complex to simple materials, the oxygen demand increased with the age of sewage, i. e., bacterial multiplication. Odors were produced as the result of oxygen deficiency and bacterial multiplication. The carbonaceous materials being the earliest attacked produced acidity, which in turn contributed to increased odor production. Studies had disclosed that after the first six hours there appeared a steady increase of hydrogen sulphide production created by sulphate breakdown. The sulphide production in the presence of slime from sewers had been more marked by far than otherwise.

The effect of staleness or septicity, Dr. Rudolfs explained, was to decrease the efficiency of settling units, thus throwing an increased burden on the stream or secondary treatment units. The chlorine demand is also increased along with the rising oxygen demand value and odors become a problem.

Dr. Rudolfs cited the following results as illustrative of sewage changes with age:

Age	pH	Free NH_3	BOD	Suspended Solids
30 min.	7.6	7	165	230
2 hrs.	7.6	12	172	227
6 hrs.	7.3	22	224	...
24 hrs.	7.2	29	238	214
48 hrs.	7.0	32	254	204

To reduce or eliminate the deleterious effects created by bacterial alteration (age) of sewage, Dr. Rudolfs suggested aeration to maintain an oxygen supply in the sewage or the use of bactericidal agents to check the bacterial growth and also to hold the oxygen in situ. Open channels such as in German sewers or artificial aeration would be one expedient. Another scheme already rather successfully employed was partial chlorination. He referred particularly to the recent experiences of the Los Angeles County Sanitation District (see WATER WORKS AND SEWERAGE for November, 1932—"Control of Sewage Condition by Chlorination," p. 369) wherein chlorination at scattered points on the sewer system had checked the solids disintegration, thus relieving the load on the activated sludge process, had controlled odors (hydrogen sulphide) and had improved plant operation.

At the Princeton Plant. Truman Curry of Nicholas S. Hill, Jr., Engineers (Behind Mr. Cowles), Explains the Design and Operation of the Plant.

In reply to a question as to the possible effect of prechlorination on subsequent sludge digestion, Dr. Rudolfs said that there would be no upper limit to pre-chlorination so far as sludge digestion was concerned. This held true because the organisms in sewage solids had no influence on digestion, lest it be a detrimental one created by the acid production noted in the early stages of digestion for which B. coli might be responsible.

PAUL MOLLITOR, Superintendent of Sewerage, Madison and Chatham, N. J., said that he recalled some early work done 17 years ago at the old Madison plant. Chlorination of the crude sewage with bleaching powder (5 to 20 p.p.m. chlorine) improved the operation of the Imhoff tanks and he was under the impression that sludge digestion had been improved also.

DR. RUDOLFS stated further that chlorine applied to sewages frequently has a coagulating power which might be of value.

"Developments in Sewage Chlorination," by A. E. GRIFFIN, Chemist, Wallace & Tiernan Company, Newark, N. J.

Mr. Griffin recounted the progress being made with sewage chlorination. Particular emphasis he placed on effluent chlorination for improving conditions of the receiving stream such as practiced at Downers Grove, Ill., Chapel Hill, N. C., Winston Salem, N. C., and elsewhere and the effectiveness of algae control in a tidal estuary by chlorinating the effluent of the Baltimore sewage works—in the latter case the lime-chlorine process being used in conjunction with copper chloride produced in a tower filled with scrap copper through which a chlorinator discharge was run.

At Elizabeth, N. J., a large trunk sewer, he said, had been effectively chlorinated to control odors during the past summer. The Los Angeles County Sanitation District sewer had been chlorinated at several points on the system with some rather remarkable results. The activated sludge plant had been able to handle the entire flow without resorting to bypassing previously found necessary.

Mr. Griffin referred to the increasing interest in chemical precipitation of sewage—ferric chloride being used in ready prepared form or produced on the ground from scrap iron and liquid chlorine.

While chemical precipitation would remove 70 to 75 per cent of the putrescibles from sewage, chlorination in addition had increased the removals further and held back putrefactive development and prevented slime growths down stream. The efficacy of ferric iron coagulation had been improved by partial pre-chlorination to hold in check reducing action of the sewage and prevent reduction of the ferric iron to ferrous which would pass out in the effluent.

In discussing odor control at Elizabeth and Princeton, N. J., the question of chlorine dosage control, for maximum economy with satisfactory results, had been a problem. Mr. Griffin said that it was patently unnecessary to add sufficient chlorine to satisfy the whole of the chlorine demand of the sewage. The question was, How much, then? The answer had been reached by making use of the well known stability test employing methylene blue indicator and adding only sufficient chlorine to destroy existing sulphides and, in addition, render the sewage sufficiently sterile to prevent fading of the blue color for the required number of hours the sewage was to be in the sewer or the settling tanks. If a sample of the chlorinated sewage collected at the outlet end of the system failed to reduce the blue color within a short time, one could be certain that odors would be no problem along the sewer. By practical test one could determine the proper index in the nature of the decolorization period permissible for a given condition and regulate the chlorine accordingly. At Elizabeth, for instance, the chlorine demand at the junction manhole where treated, had varied between 10 and 20 p.p.m. but 8 p.p.m. had proved an effective dosage as indicated by the test. A paper is now being prepared for publication, he said, which will go into detail with respect to this chlorine control procedure.

"Operating Data on Sprinkling Filters," by I. O. LACY, New Jersey Experimental Sewage Station, New Brunswick, N. J.

Mr. Lacy, in discussing specifications covering media for sprinkling filters, said that experience from their tests had shown that about the same efficiencies were obtained with slag as with crushed stone. As far as ponding was concerned the character of the applied sewage was about as important as the size stone used and that lateral movement of sewage in the beds had not extended to a depth of more than 1 ft. He said that the most satisfactory depth of filters was a subject for argument. As to filter loadings at Akron, O., the 7 ft. slag filter was giving better results than the 10 ft. stone filter and apparently 8 ft. depth was sufficient in the case of the stone. Ventilation of filters was not important and the remarkable feature of the sprinkling filter was its ability to handle such variable loadings and even severe punishments for short periods.

Ponding of filters taking place on the surface to a major extent could be relieved by mechanical or chemical method—chlorine or bleaching powder being the successful chemical method and probably the most practical of any of the schemes proposed. Chlorine applied to the settled sewage during the low night flows for several consecutive nights seemed the most economical method. The applied sewage should carry 2 p.p.m. residual or more. Experiences at Elgin, Ill., and elsewhere were cited. For filter fly control flooding of the beds seemed the most practical in conjunction with spraying of kerosene oil to destroy the adult fly.

To overcome odor difficulties pre-chlorination or preaeration was effective. The use of the rotating type distributor was also very helpful in reducing odors.

H. HEUKELEKIAN of the New Jersey Sewage Experimental Station, in discussion stressed the reliability of the sprinkling filter as a purification device and discussed the fundamentals of the filter for the benefit of the operators and did so in a very excellent manner. Basically he said the principal mechanism of the filter was the same as the activated sludge process—one depending on a fixed film and the latter on a circulating film or floc—the phenomenal thing being the rapidity of purification of sewage during its brief stay in contact with the film on the filter stone. The colloids were first absorbed then in part liquefied and oxidized—the most important feature being the stabilization of the putrescent colloids into humus like bodies not subject to rapid putrefaction. The pH of the sewage for best nitrification should be between 7 and 8. The presence of carbonaceous and other colloidal matters was inhibitory and where mostly deposited (in the upper 2 ft.) wherein no nitrification could be found. Before nitrogenous matter could be converted to nitrates the carbonaceous had to be taken out largely. While the nitrate content of effluents contributed to stability the concentration of nitrate was primarily of consequence as a yardstick for determining how thoroughly the filter was doing its intended job. So far as oxidation, as such, was involved not more than 10 per cent of the organic material would be actually oxidized by the filter—stabilization being the primary function and nitrate production but incidental to the process.

T. M. CURRY, Consulting Engineer of New York City, in referring to the selection of sprinkling filters for the new Princeton plant said that the crushed trap rock of excellent quality and cleanness had cost but 12 per cent of the entire plant cost. The bed was composed of 2 in. material and was 8 ft. deep with nozzles 13 ft. on centers. He referred to the high degree of nitrification (12 to 15 p.p.m. nitrate) and the very quick appearance of 8 parts of nitrate in the effluent after starting operations in December.

C. A. EMERSON, Consulting Engineer of New York City, rose to add a word concerning the remarkable work that filters performed even when overloaded by

almost 100 per cent. He cited the case of Columbus, O., where the filter 5 ft. deep had been in service for 27 years. The stone had not been touched although the bed was constructed for 19 m.g.d. flows and for some years had been handling 30 m.g.d. and the overall B.O.D. reduction had been 70 per cent or more.

E. S. CHASE, Consulting Engineer of Boston, Mass., referred to the Reading, Pa., filters, constructed of slag, which had served for 27 years and said that they are apparently as good as new, right now, and there seemed to be no limit to the punishment one can give a sprinkling filter.

Pollution of Bathing Places

C. G. WIGLEY, Consulting Engineer, Atlantic City, N. J., reported on a study he had conducted looking into the incidence of disease created by bathing in polluted waters. The subject of his talk was **"Pollution of Bathing Water and Its Effect on Health."**

Mr. Wigley made special reference to the reported cases of typhoid fever among bathers in the waters surrounding the New York metropolitan area, the Raritan River and Raritan Bay. Actual survey and bacteriological tests of waters of 25 beaches in the Raritan Bay area had shown that 75 per cent of the beaches should be abandoned.

Following the closing of many beaches the August and September typhoid incidence had droppjed in the New York area. The typhoid data pointed very strongly to the fact that between 54 and 1628 cases per year can be positively traced to bathing in polluted waters. If cases of infection of eye, ear, nose, and skin were reported to the health authorities by physicians, Mr. Wigley thought that the ill effects from pollution of bathing waters would be very much more pronounced. His talk was illustrated by graphs and curves to show the evidence at hand.

Sewer Rental and Licensing of Operators

"Application of the Sewer Rental Law in New Jersey" was the subject of a paper by C. A. MACDONALD of the State Department of Health, in which it was pointed out that in New Jersey sewer rental dates back to 1889 and at this date 35 municipalities charge a rental for sewer service—among them being Red Bank, Collingswood, Freehold, Pensauken and Atlantic City, which is served by a sewerage company.

The Home Rule Act of 1917 established the right of municipalities to charge a rental for sewerage service in New Jersey and such charge becomes a lien upon the premise, served, if not paid. A section of this same act requires that funds collected as sewer rental be kept in a separate account usable for paying interest and operating costs, extensions and retiring debt. In New Jersey there is no reason why sewerage systems should not be as self-supporting as any other utility. Rentals charged vary between $2.00 and $15.00 per year. The basis is variable, being on fixtures, water meter records, or minimum flat service charge and a variable rental in addition. For new installations of sewers or sewage-treatment funds are raised by assessment—the rental going to pay for operation extension and interest.

"New Rules Covering Licensing of Sewage Plant Operators in New Jersey" was discussed by J. B. BATY, Assistant Engineer of the State Health Department, Trenton, N. J.

Mr. Baty reported on the rew rules of the Department of Health pertaining to the licensing of water works and sewage works operators under the New Jersey Licensing Act of April, 1926. The proposed new rules having been presented before the association a year ago had been modified in certain directions as a result of the recommendations coming from a committee of the Association.

The new rules, he said, stipulated that an applicant for a licence should not be accepted for an oral or written examination until the applicant has given satisfactory evidence that he could pass the requirements as to operating experience and training. Also the examination to be given would be shaped to fit the existing situation thus giving more flexibility to the licensing practice. To make the rules more flexible, still, the licenses would be given under one or more of eight main classifications and one special classification in addition. In each instance the license would be restricted to the operating of a particular plant. The latter provision had been added to the new rules apparently to avoid changes of plant operators, for political or other reasons, without the approval (license) of the Department of Health being given. If so, this rule will protect the operator and the public as well, and should keep the sewage treatment works from becoming a political football.

Since the new rules had gone into effect Mr. Baty reported that there had been 54 applicants for license examinations of which 41 had the qualifications required for admission to examinations. Of the 41, 23 (56 per cent) had passed—not a material difference from the percentage passed in previous years. Mr. Baty said that the department felt justified in establishing the new rules which would insure higher grade and better prepared plant operators than heretofore.

H. P. CROFT, Chief Engineer of the Department of Health, explained that his staff was spending 10 per cent of its time and efforts in bettering the licensing situation and therefore in trying to insure better operators and improved operation of plants and farther to make it possible for the operator to think more about his work and less about his job and what would happen to it at each election. With these goals in mind he said the support of the Sewage Works Association was due the department for the selfish interests of the operators if for no other.

The remarks of Mr. Croft brought forth considerable discussion from operators, but unfortunately your reporter had to leave the meeting when Mr. Van Gill, an operator from Maple Shade, N. J., was making a fiery speech condemning the practice of even admitting non-licensed operators into the Sewage Works Association and advocating the unionization of Sewage Works Operators, if such were feasible.

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DISHPAN REFLECTORS AT HOOVER DAM.—The canyon of the Colorado about the Hoover Dam is brilliantly illuminated at night by thousands of electric lights which are ably backed up by a great brigade of dishpans. It appears that these lamps are subjected to a variety of hard experiences and to keep them supplied with reflectors which are ordinarily made use of for this purpose would be a very expensive proposition by reason of the frequent breakage. A bright new dishpan was experimented with for this service and the results were found to be so satisfactory that they were adopted all over the site. Ten thousand dishpans were ordered for this purpose.

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4,452 PERSONS EMPLOYED ON BOULDER CANYON PROJECT.—Approximately 4,452 persons were employed on the project on March 1, distributed as follows: Bureau of Reclamation, 237; Six Companies Inc., 3,678; Boulder City Co., 111; Anderson Bros. Supply Co., 131; Babcock & Wilcox Co., 9; Fred C. Snell Co., 80; Consolidated Steel Co., 6; permittees (estimated) 200.

CLARIFICATION OF WATER SUPPLIES BY FILTRATION THROUGH ANTHRACITE

By HOMER G. TURNER[1] and G. S. SCOTT[2]

IN a previous paper* the writers have shown formulae for calculation of initial loss of head, and for calculation of backwashing velocities required for various sizes of anthracite coal in water filters.

The present paper contains the results of experiments carried on to determine the efficiency of anthracite as a filter medium for removal of suspended matter, or reduction of turbidity.

Water works operators have of late shown considerable interest in anthracite as a filter material, and are of the opinion that the angular shape of particle should result in more efficient reduction of turbidity. Experimental results bear out this opinion.

After some preliminary experiments, an apparatus was constructed as shown in Fig. 1. As sand has been used for a number of years as a filtering medium, it may be assumed that its behavior under working conditions is common knowledge among water works engineers, and therefore, a comparison of anthracite with sand under identical conditions should yield information of value. The apparatus was designed with this thought in mind. The reservoir was fitted with a stirrer to maintain uniformity of the suspended solids. The turbid water was applied simultaneously to the two filters, one of anthracite, and the other of sand, the filtration rate being controlled by the float valves, and regulated to approximately 120 gallons per hour per square foot of filter area. Both anthracite and sand were carefully screened, and the sizes between 20 and 30 mesh, U. S. standard screen, were used in all turbidity tests. In order to bring out a comparison more vividly, turbidities up to 300 p.p.m. were used, and filter beds were made 12 in. deep. The solids used for suspension as turbid matter were (1) a red plastic clay; (2) infusorial earth; (3) ordinary garden soil; (4) fuller's earth.

The electric charge on the suspended particles, as determined in a transport tube, was negative for all materials used in the investigation.

Under the microscope the infusorial earth was found to consist of diatoms, 100 mu in diameter, rods 100 x 6 mu, and smaller particles about 6 mu in diameter and under. The clay particles were spherical to oval in shape and nearly uniform in size, the diameter being about 5 mu. The garden soil consisted of a conglomerate of almost everything from clay to weed seeds, some of the seeds sprouting in about one week after the filters were stopped. The fuller's earth consisted of particles, 10 mu and under, singly and in large clusters, up to about 500 mu. in length.

Comparable results could not be obtained with the infusorial earth, the fuller's earth, or the garden soil, possibly due to the excessive size of the particles, which rapidly formed a mat over the surface and clogged the filters before any regularity could be established in the effluent. Since suspended particles of excessive size would be removed in the settling basins anyway, it was felt that the results on the relatively finer suspended clay particles are more nearly representative of the conditions to be met in the actual filter plant.

The following observations of fact are of interest: When uncoagulated large and small particles in suspension are passed through a filter, the small particles pass through the bed, while the coarse particles are mechanically entangled, forming a mat which removes successively smaller and smaller particles until the filtrate becomes crystal clear. The loss of head increases very rapidly toward the end. Coagulated coarse suspensions form a denser mat on the filter surface than coagulated fine suspensions, and this denser mat is less permeable to water. Uncoagulated fine suspensions run through the filter bed, the effluent showing a constant turbidity after the initial stage. Fine suspensions coagulated with alum alone in a water deficient in alkali, are partially removed, depending upon the amount of deficiency. When the deficiency in alkali is made up by addition of soda ash, and the suspension is then coagulated with alum, the turbidity removal is almost complete.

Changes in filtration rate disturb the bed, and allow some of the turbid matter to come through the filter. There is an approximately straight line relation between the rate of filtration and the percentage reduction of turbidity on filtration. In these investigations it was found that when this rate was decreased to about 120 gallons per hour per square foot of filter surface, turbidity removal was practically complete. This relation, shown in Fig. 2, for Ottawa sand, is independent of the initial turbidity.

A test run was carried out as follows: The reservoir was filled with tap water, the stirrer started, and the clay added from a suspension in a beaker. After stirring for one-half hour, a sample was removed for determination

*"Loss of Head and Backwashing Velocities for Anthracite Coal and Water Filters," WATER WORKS AND SEWERAGE, February, 1933.

[1]Director of Research for the Anthracite Institute.

[2]Assistant Director School of Mineral Industries, The Pennsylvania State College, State College, Pa.

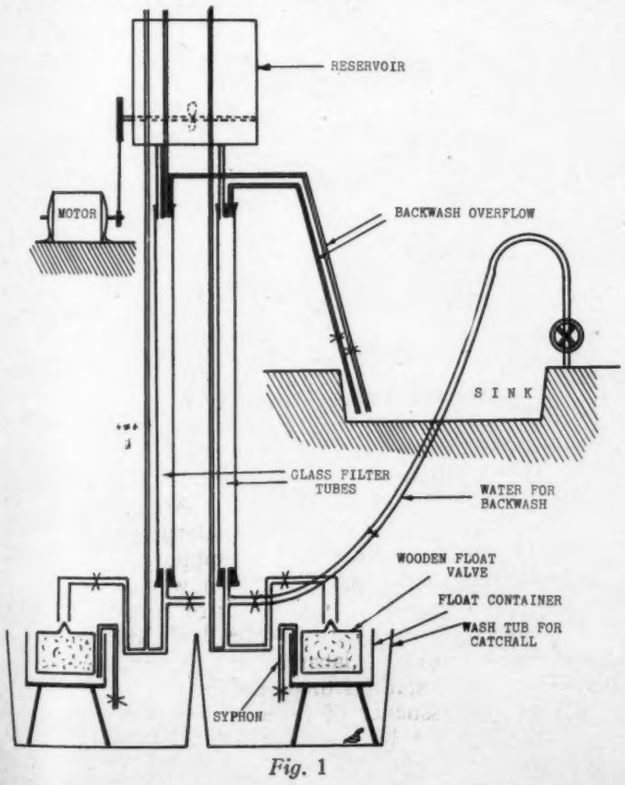


Fig. 1

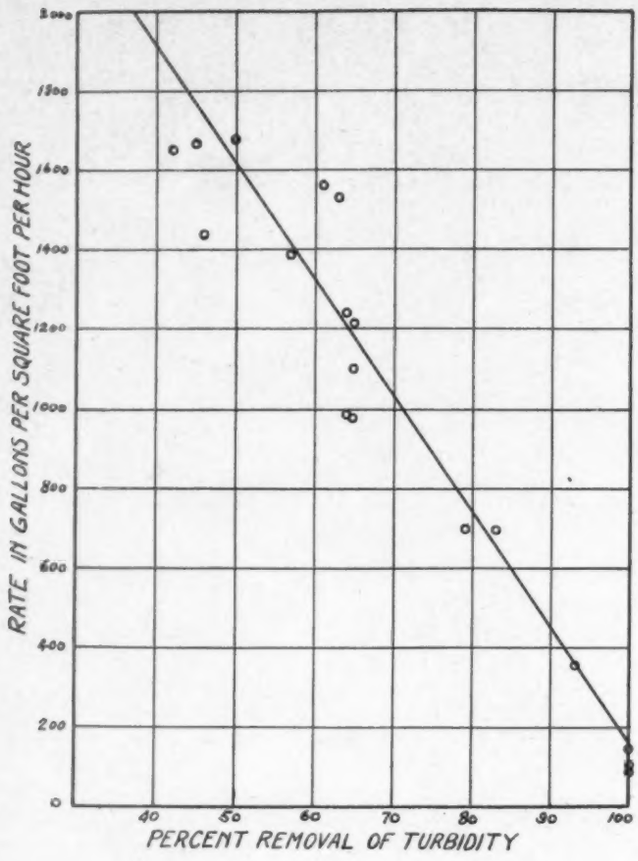


Fig. 2

of turbidity. Soda ash was then added, and the stirring continued for another half hour, at which time the alum was added. Stirring was then continued for one hour. The water was then applied simultaneously to both filters. At regular intervals, beakers were placed under the outlet syphons and samples of approximately 800 cc. taken, the time of flow being determined with a stop watch. The loss of head was read immediately after placing the beakers under the syphons. The samples obtained in these beakers were immediately measured to obtain the filtration rate, and then tested for turbidity, by the platinum wire method. The results were plotted, as shown in Fig. 3. The average turbidities of the effluents were obtained by measuring the areas under the curves with a planimeter. The length of time consumed in a single test varied up to 13 hours, depending upon the applied turbidity and the head loss. An attempt was made to set the rate at about 125 gallons per hour per square foot at the start of the test, and was thereafter allowed to take its own course. The filter beds were backwashed after each test by means of the arrangement shown in the sketch. The quantity of water used in backwashing depends to some extent on the judgment of the operator. In these tests, approximately equal quantities of water were used for both coal and sand, and with similar results so far as the eye could detect. The beds were expanded about 50 per cent during backwashing. The coal required about half the backwashing velocity that was needed by sand to produce this expansion. The quantity of wash water on a percentage basis naturally depends upon the length of filter run, and this, in turn, is inversely proportional to the amount of turbidity, other factors remaining constant.

The Table I summarizes the test data obtained with clay.

TABLE I

Coagulation Treatment	Applied Turbidity	% Reduction in Turbidity Anthracite	Sand
None	81	7	7
Alum only	43	40	40
Alum only	45	49	49
Alum and soda	45	95	78
Alum and soda	50	90	80
Alum and soda	185	89	75
Alum and soda	225	91	80
Alum and soda	300	99	93
Average	...	93	81

Since test with clay has been omitted, the results indicate very strongly that anthracite possesses greater efficiency than sand in the matter of turbidity reduction. The superiority of anthracite is believed to be due largely to the angular shape of the particles. Experiments are now under way to throw further light on this point.

Experiments are also being carried out with improved rate controllers that show a constancy within 1 per cent, using a photo electric cell for turbidity measurements, to determine the length of filter run for different sizes

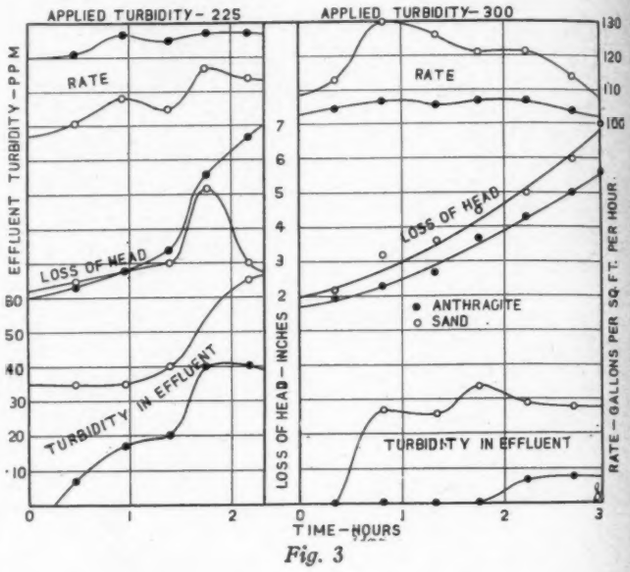


Fig. 3

of anthracite as compared with different sizes of sand.

The writers wish to acknowledge the cooperation of the Mineral Industries Experiment Station, the Pennsylvania State College.

States Modernize Laws to Speed Sewage Works

To enable cities and towns to obtain Federal money for work-relief programs, many states are revising laws so that sewerage facilities can be operated on a self-liquidating basis, with income derived from service charges instead of general taxation.

The Emergency Relief and Construction Act for 1932 authorized the Reconstruction Finance Corporation to lend money to municipalities for self-supporting construction projects that can pay their own way, so that property will not be taxed for repayment of loans.

Since the passage of the Relief Act last July, five states—Indiana, Kentucky, Alabama, Oregon and Texas—have amended their statutes to permit sewer rental or service charges, and issuance of revenue bonds for sewerage projects which can be sold to the R. F. C.

CHLORINATION CONTROLS FOAMING IMHOFF TANKS

Experiences at Stockton, California

By FRED WEST

Superintendent, Southside Sewage Treatment Plant, Stockton, Calif.

THE following is a brief summary of the results secured during a test of pre-chlorination in controlling foaming in Imhoff tanks at the Southside Treatment Plant of the city of Stockton.

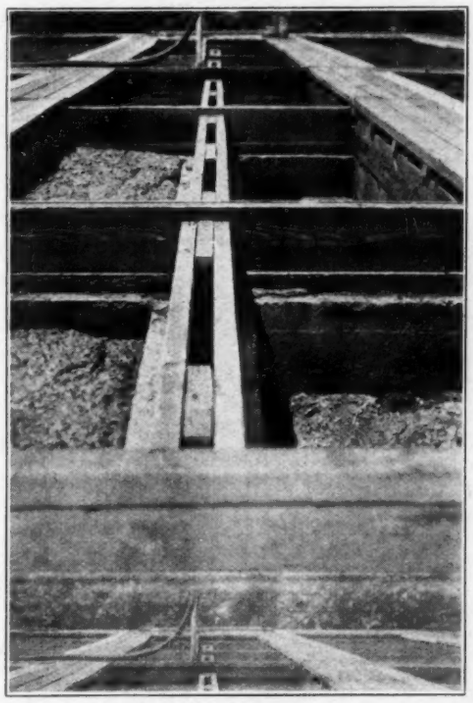
The plant serves about half of the city area with a tributary population of approximately 20,000. A number of industrial plants, including canneries and a cheese factory, contribute to the flow. The gravity outfall line to the plant is approximately 2½ miles long, requiring from two to four hours in travel before the sewage arrives at the plant.

At the treatment plant, after the sewage passes through bar screens it is lifted by suitable pumps to the two Imhoff tanks which are operated in parallel. Each tank is 28½ ft. wide by 57 ft. long and each tank has two flowing-through chambers 9 ft. wide by 55 ft. long. There are three gas vents in each tank, the gas vent area totaling about 26 per cent of the total tank area.

The average daily flow is from 1½ to 2 m.g.d. During the period of the test the average pH value of the raw sewage was 7.1.

At this plant they have had more or less continuous difficulty from foaming. This occurs practically the year round but foaming is accentuated during the different canning seasons. The sides of the gas vents have been raised by the use of timbers and the scum resulting from the foaming has in the past been broken up and kept down by constant hosing with fresh water under pressure.

During the months of April, May and June, 1932, pre-chlorination was tested to determine its effect in the control of this foaming condition. After some preliminary runs the dosage was set, about the middle of April, at a rate of 45 lbs. per 24 hours (about 3.5 p.p.m.) and the chlorinator operated for about 16 hours a day. This resulted in a total consumption of chlorine amounting to approximately 30 lbs. per day. During all of the tests, the sewage going to only one of the Imhoff tanks was treated, the sewage going to the other tank being untreated and therefore acting as a control for comparison of results. The results were very encouraging and photographs taken on April 26th, after ten days of operation, show a very decided improvement. One of these shows gas vents in one side of the treated tank and the adjacent ones in the untreated tank. In the tank which had been treated the scum in the gas vent is shown well below the level of the concrete wall while in the other tank it is, in places, over the top of the concrete wall and part way up the wood extension.



Effects of Prechlorination on Foaming Imhoff Tanks, Stockton, California

Gas vent on left serves the unchlorinated tank—that on the right the chlorinated. Photograph taken 10 days after chlorination was started at dosage of roughly 4 p.p.m. applied during a 16-hour period daily

Shortly after this date chlorination was stopped, pending warmer weather when it was anticipated foaming would be worse. On the 10th of May chlorination was started again, using an increased dosage of 60 lbs. per 24 hours (about 4 p.p.m.) for 16 hours a day, resulting in a total usage of chlorine of 40 lbs. per day, or an average of 3 parts per million. This 16 hour period in all cases was from 6 a. m. to 10 p. m. The accompanying photograph was taken on the 20th of May, after ten days' operation, showing treated and untreated gas vents, speaks for itself as to the results accomplished.

In addition, although no exact tests were made during the period of chlorination, it appeared that there was a definite improvement in the clarity of the effluent from the treated Imhoff tank, apparently resulting from improved sedimentation and lack of solids coming up through the slots in the flow chamber.

These tests, which were very convincing, were made under the supervision of Mr. Lyle Payton, City Engineer, and the author. We are indebted to the Wallace & Tiernan Co., who supplied a vacuum solution feed chlorinator, and to the Great Western Electro-Chemical Co., who furnished chlorine. Mr. Ralph A. Stevenson of the Great Western Electro-Chemical Company's field staff, and Messrs. Emerson Dolliver and A. C. Beyer of Wallace & Tiernan Co. assisted during the work.

[Note: On another page appear comments made by Dr. W. Rudolfs in discussing the effect of prechlorination upon the digestion of sewage solids. See the report covering the "Meeting of the New Jersey Sewage Works Association," which appears elsewhere in this issue.—Editor.]

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COLORED WATERPROOF DRAWING INKS.—The U. S. Bureau of Standards has, at the request of a government department, recently completed work on the preparation of a number of water-fast drawing inks which do not deteriorate on storage for a period for at least one year. These inks consist of an aqueous 5 per cent shellac solution to which has been added a small quantity of phenol, borax and a dye. The shellac used was not bleached but was freed from natural waxes and dirt. Of 92 dyes investigated, only 17 were found to be at all suitable for this purpose.

WATER SUPPLY FOR TANNERIES

By AUG. C. ORTHMANN
President, The Orthmann Laboratories, Inc., Milwaukee, Wis.

PRESENT day tanning operations are decidedly different from those of fifteen or twenty years ago. Changes which have been effected since that time are not only the result of technologic progress in the industry, but also to discriminating demands by the shoe industry to produce for my-lady-fair shoes of colors and shades in keeping with the everlasting changing hues of dress goods, hose, and hat. As the textile industry has suffered because of the scantiness of women's attire, so also has the leather industry because of the lack of leather in women's shoes.

August C. Orthmann

With this introduction some of the changes which have taken place in the leather industry, and in which the water supply plays an important part, will be reviewed.

Prior to 1893 practically all utility leather was tanned by what is commonly referred to as The Vegetable Tanning Process. For this process the natural vegetable tanning materials obtained from barks, woods, and leaves were used. The dried materials are leached with hot water, thereby extracting the soluble matter which contains the valuable tanning agent. Since 1893 the chrome tanning process has made appreciable inroads upon the vegetable tanning process. At the present time more than 90 per cent of shoe upper leather is made by this process.

For this purpose chromium salts are used. Two methods of application are in general use. One known as the "Two Bath" process, in which bichromate of soda is first applied to the prepared skins and hides which is then reduced to a basic chrome salt by introduction of an inorganic acid and sodium thiosulfate. The other, known as the "One Bath" process, is one in which a basic chrome salt, such as the chloride or sulfate is directly applied to the prepared skins and hides. The basic chrome salt is prepared beforehand by reducing chromic acid with corn sugar or sulfur dioxide.

The two tanning processes differ widely both as to application and in the properties of the resulting leather. Chrome tanned leather is produced in a shorter period of time than vegetable tanned leather, and has found greater favor because of the ease of coloring it to any shade wanted in order to meet the demands created by the fad for color in shoes.

Aug. C. Orthmann, the author of this article, has been connected with the tanning industry since 1908, having been Chief Chemist of one of the largest tanners in America—Pfister & Vogel Leather Company. Since 1929 he has been President and Director of his own laboratories, serving the industry.

This, the first of two articles dealing with "Water Supply for Tanneries," will be followed by a second, dealing with the "Quality and Quantity of Water Required in Tanning—and its Treatment."

As the author states, the supply of available water, both as to quantity and quality, is such an important item in leather tanning that it frequently becomes a deciding factor in selecting the location of a tannery. This first article is intended to familiarize the reader with water usage in tanning operations and the process in general. The second will discuss requirements as to quantity and quality of the supply.—EDITOR.

Classification of Leathers

Leather is divided into two general types, heavy and light. These are distinguished by the weight of the raw material used, viz., light leather is made from a skin weighing fifteen pounds or less, the weight being that of a well salt cured skin. Heavy leather is made from a hide weighing sixteen pounds or more. Each type is subdivided. Thus the light leather includes: Calf, kid, sheep. Each type is used also for a variety of purposes other than shoes. Heavy leather is subdivided into: Kip, cow, steers, bulls, horse, kangaroo, etc.

A large percentage of the lighter raw material of the heavy leather group is used for purposes for which some of the lighter leather is used and for that reason it is difficult to draw a sharp line of demarkation. All hides weighing forty-two pounds or more, however, can be classed as heavy leather hides.

The two generally used tanning processes (vegetable and chrome tannages) are used for producing leather made from raw material in both groups. Chrome tanned leather however, predominates in both groups excepting that in the heavy leather group sole leather is largely produced by the vegetable tanning process.

Hides and skins pass through a large number of operations before the final product is obtained. The treatment of the raw material up to the tanning stage is quite similar for both tanning processes, a brief description of which follows.

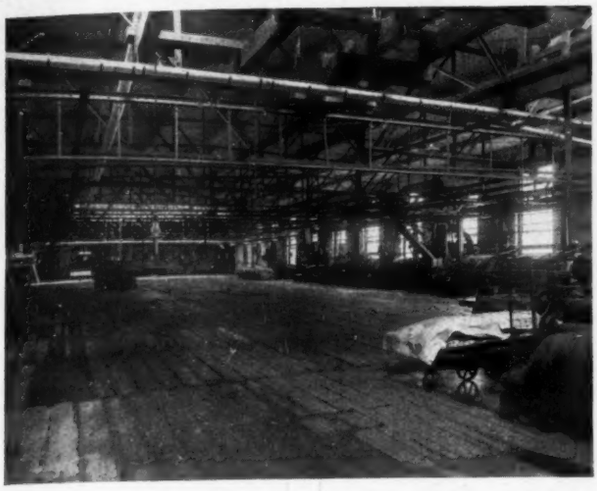
Hide to Leather

The raw material as received by the tanner is first trimmed and sorted according to weight and size of hides and skins. Each assortment is made up into a "pack." A pack consists of a definite number of pounds of raw material, which varies with each tanner, and may be from 2,500 to 6,000 pounds. The size of the pack is governed by the size of equipment such as vats, paddle wheels and drums. The tanner endeavors to keep each pack intact and have it pass through all operations as a unit.

All raw stock is first soaked in water for a period of from twelve to forty-eight hours, after which it is thoroughly washed. Soaking may take place in vats or paddle wheels which vary in capacity from 1,000 to 2,000 gallons. If the stock is soaked in vats it is transferred to open end drums or paddle wheels for thorough washing. Subsequent treatment demands that all dirt and salt be washed from the stock. After the stock is well washed it is "fleshed." This operation is performed on a machine for that purpose which removes all extraneous flesh, fat, and some of the adipose tisseu.

Dehairing

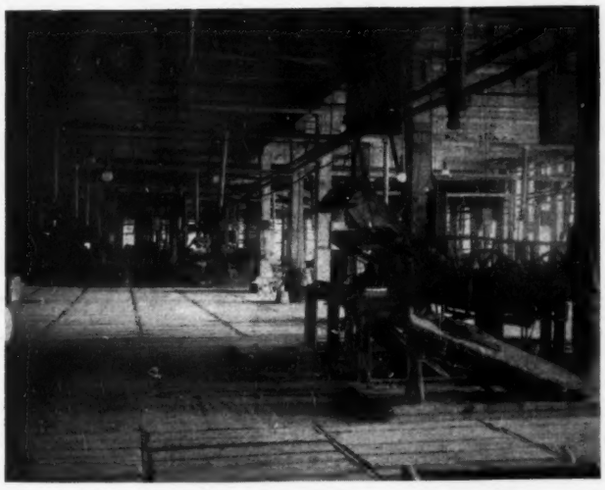
For this purpose saturated lime solutions, carrying an excess of lime, are used. Dehairing is greatly accelerated by the use of reducing agents such as sodium sulfide which is added to the lime solutions in varying quantities ranging from ¼ to 1 per cent of the weight of the stock. This operation takes place in either paddle wheels or in vats. The stock remains in the "limes" from three to seven days after which time the hair having become quite loose can be removed readily. Unhairing is performed



Typical "Tanyard" with Covered Vats. In the Right Background Are a Battery of Drums

on a machine. The work is laid on a flexible apron of heavy rubber and a cylinder covered with blunt spiral knives plays over the hair side of the stock accompanied by a spray of water. The loosed hair is washed into a recess in the floor from which it is recovered.

Often stock is difficult to unhair or it contains fine hairs which are not removed by the machine. They are later removed with a moon shaped knife by skilled oper-



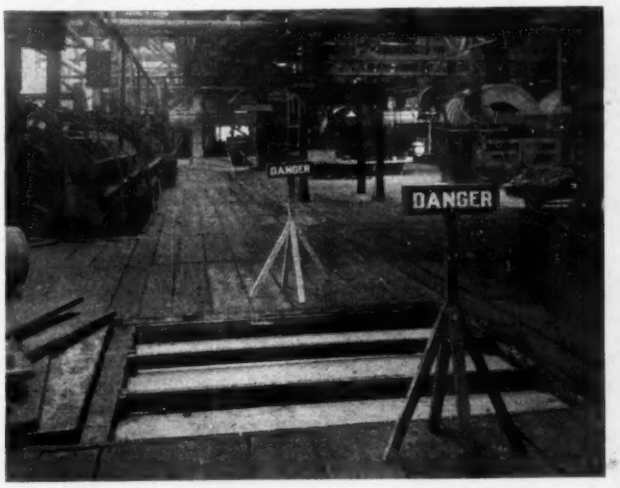
Section of a "Beamhouse." Covered Lime Vats Serve as a Floor. The Half Round Table at the Right In a "Beam"

ators. This operation is performed upon a half round table known as a "beam" from whence the term "beamhouse" originates. Before the advent of the unhairing machine all hides and skins were unhaired by hand on the "beam." Following the unhairing operation the stock is "refleshed" after which it is thoroughly washed in either paddle wheels or open end drums.

Bateing

Originally this operation was performed by the use of dungs, the source being that from dogs and fowls. The "bates" were first prepared by steeping a quantity of dung in warm water and permitting the mass to ferment for a period of from 48 to 72 hours. Bran was also used for this purpose. Fermentation produced small quantities of organic acids. The function of the acid was to neutralize lime remaining in the stock. Enzymes, present before or produced during fermentation, produced a decided effect on the stock after the acid had been spent. The use of such products caused considerable stench in and about the beamhouse which without doubt was one of the reasons for intensive research as to the function of the products and a desire for a more definite material to replace them. The result of investigations indicated that pancreation would function to better advantage than bran or dung. Commercial bateing materials of the present time are mixtures of pancreatin wood flour and chloride or sulfate of ammonia. Fermentation is no longer necessary and consequently little or no odor is produced.

The bateing operation varies decidedly with the type of stock and kind of leather produced. The principal function is to remove lime from the stock and reduce the plumpness caused by the dehairing operation. The enzymic action removes or effects part of certain proteins, which, if permitted to remain produce a leather of undesirable firmness. The stock is bated at a temperature of from 80 to 95 deg. F. for a period of from thirty



The "Beamhouse" Showing at the Right, Open End Wash Drums, in the Foreground an Open Lime Vat.

minutes to one hour, after which it is washed well in paddle wheels. Following this operation stock can be diverted to either the chrome or the vegetable tanning process.

Vegetable Tanning

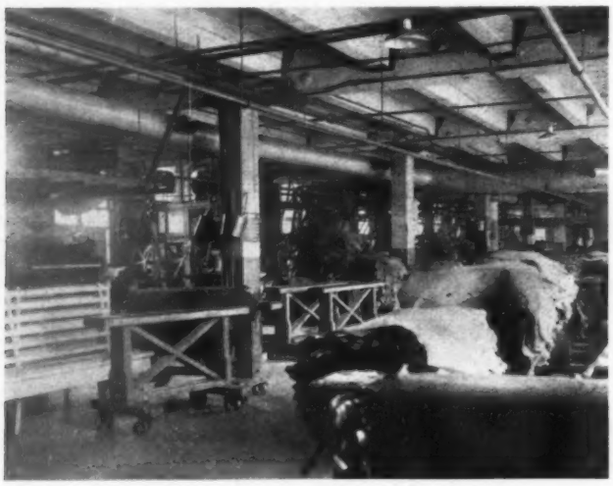
Practically all vegetable tanning is done in vats. This applies particularly to the beginning of the tannage. The hides and skins are usually suspended into vats which are fitted with a frame work to which the hides are attached. This frame work can be caused to rock like a cradle, hence the name "rockers" is applied to these vats. The tanning solutions commonly called "liquors" are used in strengths ranging from ½ to 4 per cent in pure tanin. The stock first is placed into the weaker "liquors" and by means of the "press" system the liquors are changed daily, the stock remaining in the same vat. The "press" system refers to the flow of the liquor, due to differences in specific gravity, from the "head" to the "tail" vat where part of the latter is drained. "Tail" is the weakest

liquor and "head" refers to the stronger or fresh liquor. Each series of vats are connected, usually by logs.

After the stock has been subjected to each of the rocker liquors, that which was the "head" or strongest liquor, finally becomes the "tail" liquor, a new "pack" of stock having been added to the series daily as part of the "tail" liquor is rejected. Before the advent of the "rocker" the stock was transferred from vat to vat daily; the term "handlers" applied to such a system.

Having passed through the "rocker" system, the stock is now placed into "layaway" vats which contain stronger tan liquors than those of the head rocker. Such treatment is applied particularly to heavy stock such as is used for sole leather. The stock remains in the "first" layaway for a period of ten days, after which it is placed into a "second" or stronger layaway for a period of twenty days, finally it is placed into a "third" layaway where it remains for twenty to thirty days. Thus the stock is subjected to progressively stronger tanning "liquors" until it is thoroughly tanned.

Heavy stock for sole leather is not subjected to washing, but it is "scoured" by means of a stiff brush whilst water is sprayed over the surface of the stock. Except-



Leather in Finishing Department

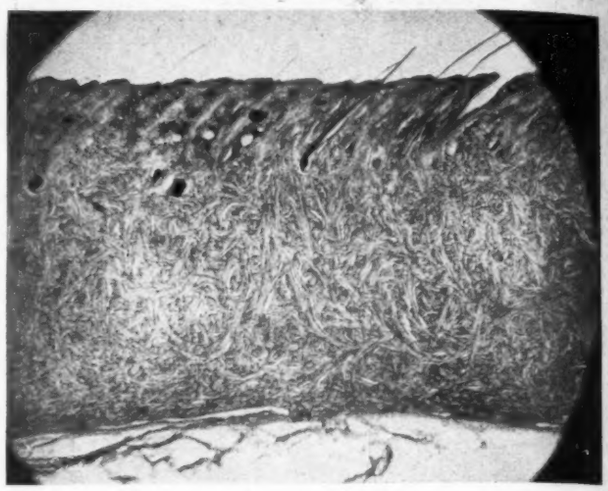
ing for treating the leather further with tanning extracts, oils and greases, the use of water ends at this stage.

Lighter stock such as calf or light cow hides are usually not subjected to the "layaway" liquors, but are tanned through in the rocker system. After the lighter stock is removed from the rocker system, it is subjected to a wringing to remove as much water and un-combined tan solution as is possible, after this, it is "set out" to remove creases. As all hides and skins vary in thickness, they must be split to an even thickness, after this has been done the stock is "retanned" by milling it in a strong tanning liquor. This is done either in a paddle vat or in slow running drums, and requires from four to six hours' time. The stock is then piled flat and allowed to "mull" for one to three days and is again "set out" and dried.

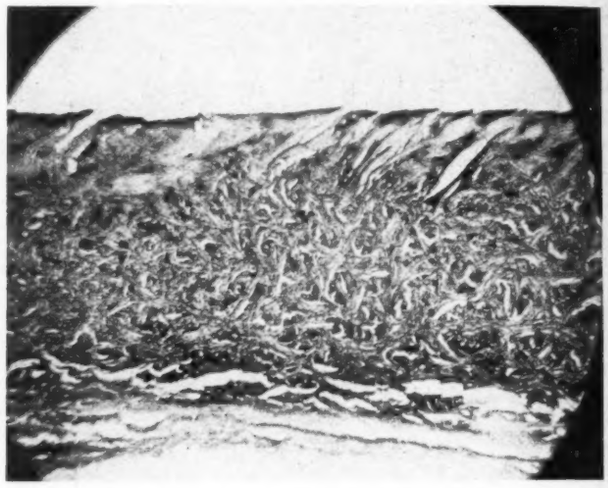
After this the stock is sorted and graded according to the demand of the market. It is then divided into lots of three-hundred to six-hundred pounds, returned to the drums, wet back and washed thoroughly, colored, and treated with oil emulsions, dried and finished.

Chrome Tanning

After the stock is well washed out of the bate it is pickled in salt and acid. This process dehydrates the stock and prepares it for the tannage proper. Pickling is performed in paddle wheels. The strength of salt solution used may vary from 8 to 12 per cent, the amount of acid used is based on the weight of the stock and varies from 1.0 to 2 per cent. This operation requires



A Cross Section of a Piece of Hide Showing the Density of the Hide Fibres. Magnified About 80 Times



The Same Hide as Shown Above After Bateing Showing a More "Open" Fibre Structure Due to Process of Liming, Bateing, and Washing

about four hours' time. The stock is well drained after it is removed from the pickle solution.

After draining, the stock is placed into paddle wheels or drums and tanned either by the one or the two bath process previously described. This is accomplished in from five to seven hours' time in the drum, and about forty-eight hours' time in the paddle wheel.

After the stock is thoroughly tanned it is allowed to rest for twenty-four hours, is then put through a wringer, set out, split and sorted, made up into units of from 300 to 600 pounds, neutralized and thoroughly washed in drums with hot water, then colored and treated with oil emulsions, again set out, dried and finished.

The number of operations both mechanical and manual approximate about forty in all from the time the raw material is received at the tannery until the leather is ready for the market. It is carefully inspected at each stage and sorted at four of the many stages.

The purpose of the article is to give the reader sufficient detail of leather manufacture so he may appreciate the necessity of adequate water supply at the various stages. This will be discussed in the second installment to appear in a future issue of WATER WORKS AND SEWERAGE.

THE GENERATION OF HYDROGEN SULPHIDE IN SANITARY SEWERS

Some of the Contributing Factors and Their Importance

By FRED D. BOWLUS and A. PARRY BANTA

Respectively Resident Engineer and Assistant Engineer, Los Angeles County Sanitation Districts, Los Angeles, Calif.

A DIGEST of data procured during an extensive sewage survey*, conducted for the Los Angeles County Sanitation Districts, discloses some interesting factors effecting the generation of hydrogen sulphide. The conclusions drawn as to effective factors are based in part upon the analysis of some ten thousand sewage samples for each of which temperature, pH value, hydrogen sulphide content and chlorine-demand were determined; partly upon many hundred samples for which 5-day B.O.D. (20° C.) was made; and also upon measured quantity and velocity of flow of the sewage observed at many points on the system.

The samples from which this study was made, were taken from that portion of the districts' system tributary to the Joint Districts activated sludge disposal plant. The area drained comprises about 200 square miles, takes in 15 incorporated cities, 16 unincorporated communities and a considerable area of suburban and industrial development. Sewage characteristics vary widely in individual trunk sewers.

Effect of Temperatures on Septicity and Sulphide Generation

The maximum sewage temperatures in the Los Angles District are recorded in the month of September. In 1931 the September temperatures averaged 79° F., while the corresponding average for 1932 was 76° F.; a difference probably due to the moderate air temperature during the summer of 1932. The minimum average sewage temperatures, 64° F., were recorded in February, 1932. In the upper trunks the daily variation was as high as four degrees and at the disposal plant two degrees. It will be noted from Fig. 1 that, with a slight lag, the sewage temperature curves follow in general the 50-year mean temperature curve. Daily as well as seasonal variations occur in the quantity of hydrogen sulphide to be found at a given sampling point. The seasonal change varies with the sewage temperature but the daily change varies with the flow. Typical examples of the effect of seasonal variation in sewage temperature on the hydrogen sulphide generation are shown in Fig. 2, in which the dashed and dashed-dotted curves show hydrogen sulphide generated at 79° and 64° F., respectively.

Effect of Velocity on H_2S Generation

Flat grades and slow velocities have a marked effect on the generation of hydrogen sulphide (see Fig. 3, solid line curves). The upper curve (dashed) represents conditions for a sewage which has traveled a distance of nine miles at a velocity of two feet per second. The lower curve is drawn from analyses of the same sewage on the same days but after the sewage had proceeded two and one-half miles further at a velocity of one foot per second. In general hydrogen sulphide found at any given point is the balance between a progressive generation and its liberation into the sewer above that point. There is some question as to whether the difference, shown in Fig. 3, is caused by greater release of hydrogen sulphide resulting from increased turbulence at high velocities, or the presence of sludge deposits in the line having slower velocities. Undoubtedly both factors are important but it is believed that the influence of sludge deposits is greater. Such deposits provide a semi-stationary seeding media and have an oxygen demand in addition to that of the flowing sewage.

Effect of Sulphate Content on H_2S Generation

To date the data gathered to show the effect of the sulphate content of the sewage on hydrogen sulphide gen-

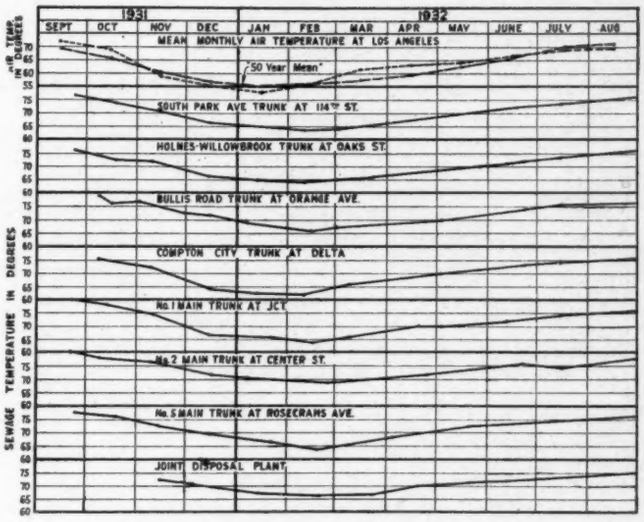


Fig. 1.—Sewage Temperatures

eration is meager and inconclusive. Apparently there is sufficient sulphate concentration in practically all of the water supplies tributary to the Los Angeles County Sanitation Districts' system to support hydrogen sulphide generation. The sulphate content of the water supplies of ten of the cities contributing sewage, ranges from 40 to 60 p.p.m.

Effect of Sewage Strength on H_2S Generation

The general shape of the hydrogen sulphide curves suggests a correlation between strength of sewage and hydrogen sulphide generation. Figure 4 shows hydrogen sulphide plotted against B.O.D. for hourly samples taken at the joint disposal plant. Apparently the amount to be found at any point depends to some extent upon the strength of sewage as represented by the B.O.D., all other conditions such as temperature, sulphate content and sewage velocities being equal. In Fig. 3 the recent high hydrogen sulphide represented by the dashed curve found on the No. 2 Main at Center Street corresponds to a radical increase in the strength of the sewage due

*For a description of the survey made before and after chlorination was started, the reader is referred to a previous article, describing the "Control of Sewage Condition by Chlorination," which appeared in the November, 1932, issue of WATER WORKS AND SEWERAGE.

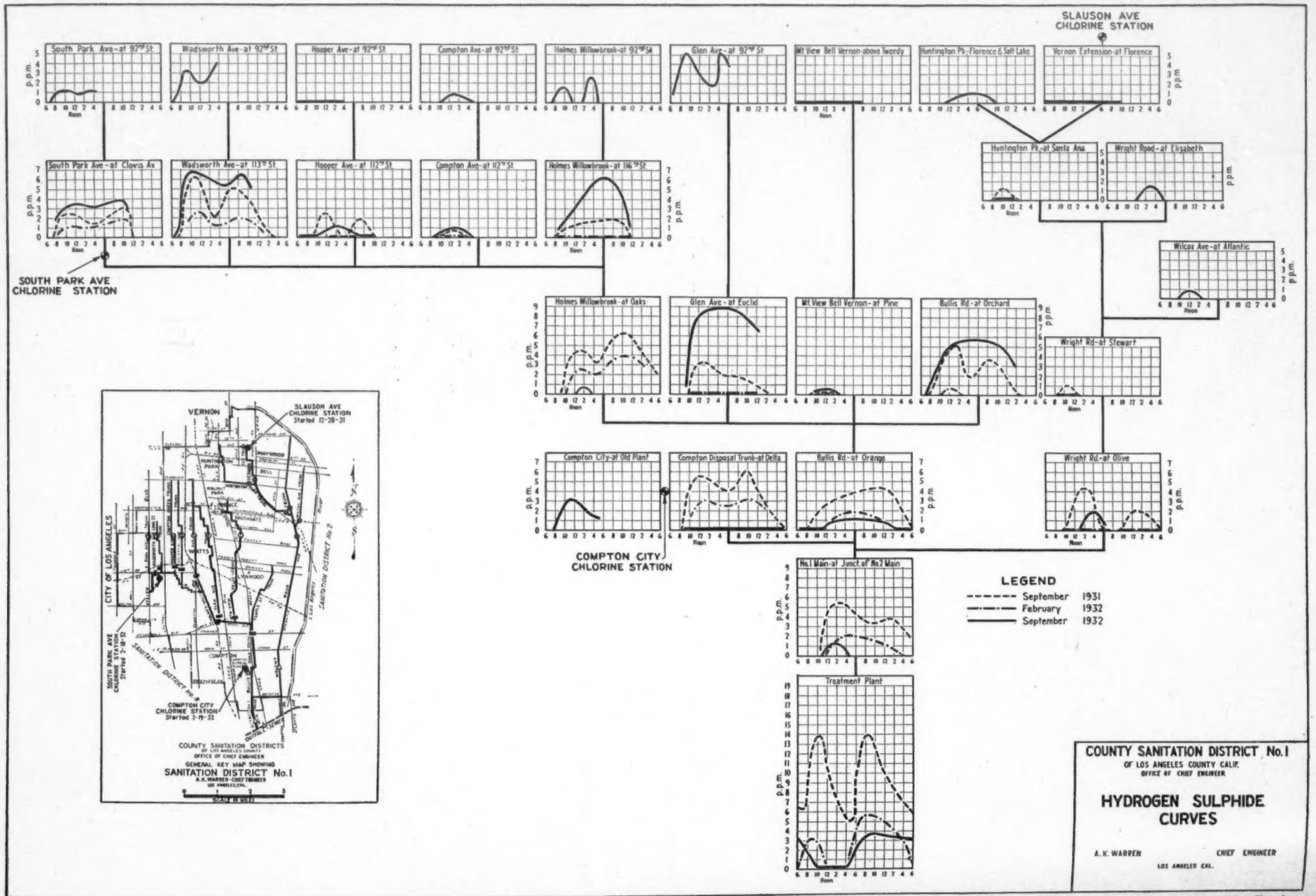


Fig. 2.—Hydrogen Sulphide Data Taken at Several Points on Sewers in Los Angeles County Sanitation District No. 1. (a) Without Chlorination in September, 1931; (b) During Chlorination at Indicated Points During 1932. Dash Lines Temperatures = 79° F.; Dash and Dot Lines Temperatures = 64° F.

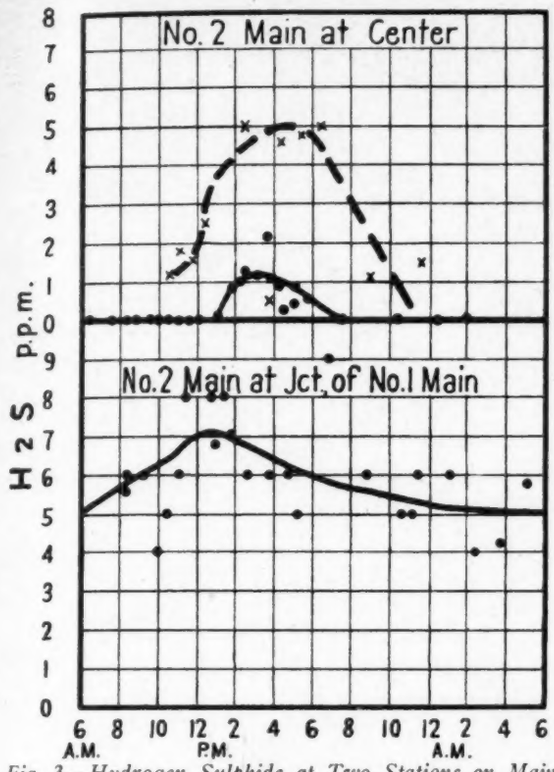


Fig. 3.—Hydrogen Sulphide at Two Stations on Main Trunk Sewer

to the discharge of a waste high in dextrose. The acceleration of sulphate decomposition in the presence of yeast may also have been a factor. Since the activities of this plant contributing the dextrose have ended conditions in the No. 2 Main at Center Street are about as represented by the solid line curve.

Relation Between Chlorine Demand and B.O.D.

Results of analysis of sewage taken at the joint disposal plant also indicated a close correlation between B.O.D. and chlorine demand. Figure 5 shows this relation in samples taken over a 24-hour period. These data indicate that the ratio of the chlorine demand to B.O.D. was about 1 to 10. It must be borne in mind, however, that the chlorine demand is influenced by the age, temperature and particularly the hydrogen sulphide content of the sewage. For a given sewage at any given

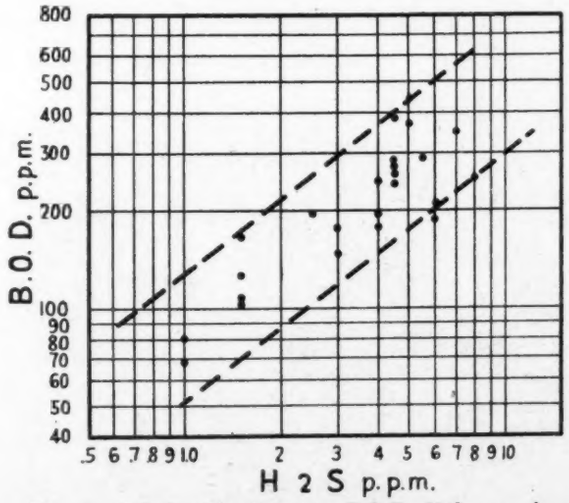


Fig. 4.—Relationship Between B.O.D. Values and Hydrogen Sulphide in Sewage

point the ratio may be a constant, but it will probably be numerically different from the ratio 1 to 10. Packing house wastes gave a ratio of chlorine demand to B.O.D. of 1 to 17 and it is probable therefore that ratios will vary with different sewages. Sewage having a high content of hydrogen sulphide gave a ratio of 1 to 7. At the joint disposal plant, when the pH value was greater than 9.0 the ratio was 1 to 7½. This relationship between the chlorine demand and the B.O.D., while not definite, did prove of practical value in tracing industrial wastes.

Separate cases as defined by conditions found in the different main trunk sewers seemed to emphasize the importance of different factors. As an instance a sewage with high temperature, flowing at two feet or more per second velocity, produce little hydrogen sulphide. Another flowing at like velocity, with lower temperature, but containing a strong packing-house waste, showed high hydrogen sulphide generation. Normal domestic sewage of moderate temperature flowing at velocities which permitted solids deposition, indicated rapid generation of H_2S. All sewages showed a seasonal and daily variation according to temperature and flow respectively. The

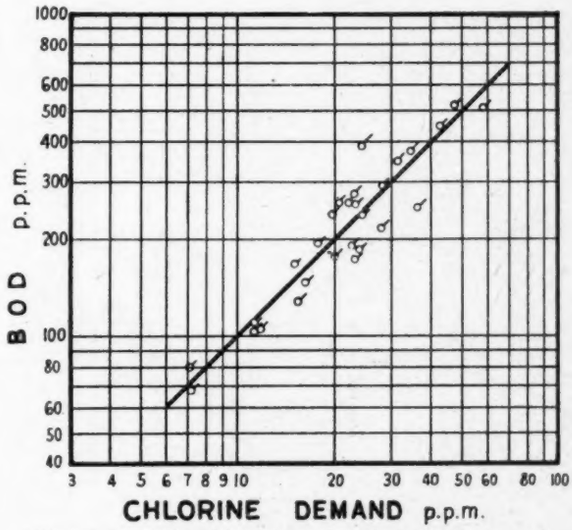


Fig. 5.—Relationship Between B.O.D. Values and Chlorine Demand of the Sewage

conditions to be expected under any circumstance can apparently only be defined by evaluating all probable factors.

The one factor of greatest consequence in hydrogen sulphide production is the temperature-time factor, which is another way of saying that at higher temperatures the sulphate splitting organisms are more active and therefor there is a decided relationship between time and volume of hydrogen sulphide produced as the temperature increases.

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Low Typhoid Death Rate in Maryland.—The lowest typhoid fever death rate experienced in the history of the state of Maryland occurred this year in the midst of the depression. A death rate of 3 per 100,000 was reached in 1932, with virtually none of this attributable to public water supplies. The unusually low record is no doubt the result of number of years of activity in the control of water supplies, sewerage and food supplies, together with the general supervision resulting from full time county health officer operations.

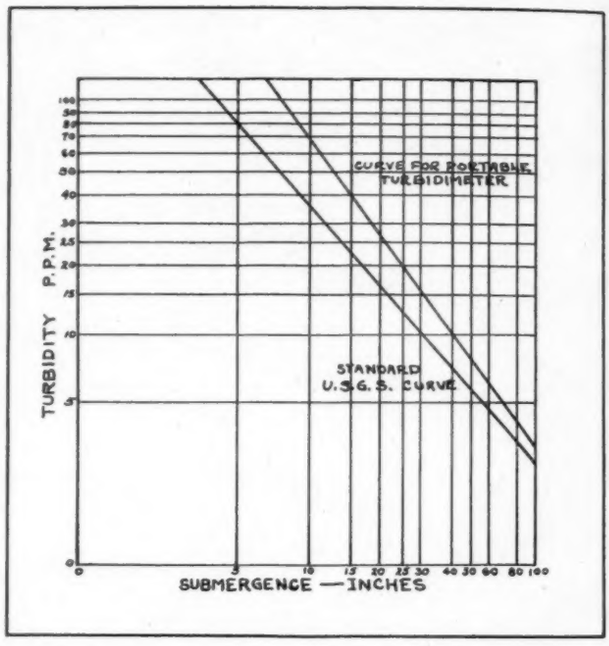
Fig. 2.—Hydrogen Sulphide Data Taken at Several Points on Sewers in Los Angeles County Sanitation District No. 1. (a) Without Chlorination in September, 1931; (b) During Chlorination at Indicated Points During 1932. Dash Lines Temperatures = 79° F.; Dash and Dot Lines Temperatures = 64° F.

AN IMMERSION TURBIDIMETER AND SLUDGE BLANKET DETECTOR

By DON E. BLOODGOOD
Engineer, Sanitation Plant, Indianapolis, Ind.

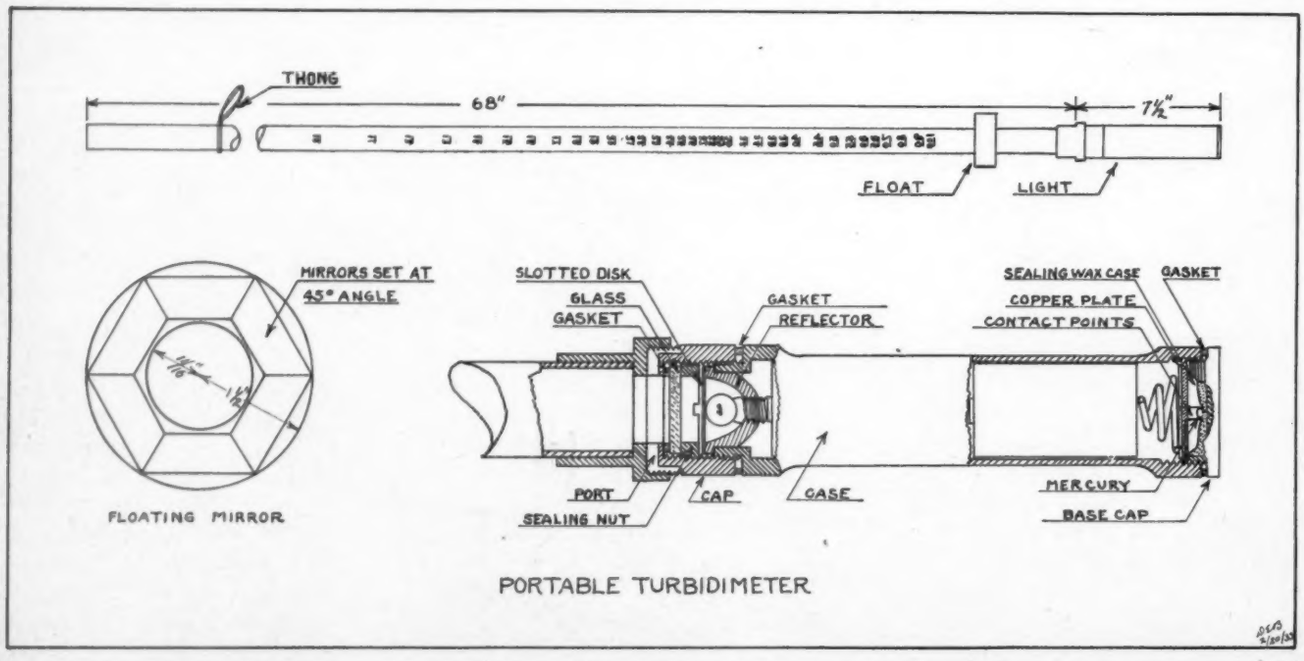
TO a sewage plant operator, the appearance of the effluent is the best indication of the effectiveness of the treatment process. But to convey to the superintendent an accurate description of the appearance, in writing, is difficult. A superintendent should know each morning the hourly condition of his plant during his absence. He also wants his operators to be able to tell him how one day's effluent compares with that of any other day.

To supply this information in the most concise, yet explicit form, an instrument has been constructed at the Indianapolis Sewage Treatment Works which can be used as a portable turbidimeter and a sludge blanket detector. It consists of an 1¼ inch I.D., 0.065 wall, 2 FH aluminum tube 68 inches long with a sleeved brass collar on the bottom into which the brass moisture proof lamp case screws. There are four ports in the cap which admit water but exclude all outside light. The glass disk is held against a rubber gasket making a water tight joint. In the 1/32 inch metal disk there is cut a ¾ inch cross of 0.012 inch opening with the center closed off by a piece of metal not larger than 3/32 inches in diameter to blank out the bright spot caused by the bulb filament. The light reflector is painted with aluminum paint. The operation of the lamp is identical with the ordinary two cell flashlight except for the self-operating mercury switch. This mercury switch is in the base cap of the lamp case and is constructed in a case of sealing wax. The sealing wax was first run into the base cap and sloped to a small depression in the center. A short piece of No. 24 platinum wire was set on each of opposite sides of the depression with the ends about ⅛th of an inch apart. One wire is grounded to the base cap and the other is connected to a copper plate, making a connection with the battery through the coil spring. Only a very small drop of mercury is needed in the switch. After the mercury is placed, a heavy paper disk is set over the top of the mercury pocket and the cap is filled with sealing wax.



Graph for Converting Submergence Into Turbidity Reading

In use, the instrument is submerged to a point at which the cross disappears and then the scale on the side



Portable Turbidimeter and Sludge Blanket Detector Used at Indianapolis Sewage Treatment Works

of the tube is read by looking into the six-sided mirror of the float, in one plane of which the figures will show. The mirrors are set at a 45° angle with water proof china cement in sycamore or any other tough light wood.

The portable turbidimeter was calibrated by getting the submergence in effluents of known turbidity. This data when plotted on logarithmic paper gave a curve somewhat different than did the data of the standard U.S.G.S. turbidity table, as can be seen by the accompanying graph. The scale for any turbidimeter constructed could be obtained from the graph of the calibration data or it could be calculated by developing a formula for the particular curve, similar to the formula of the standard curve:

$$\log y = -1.106598 \log \times + 2.6570$$

in which y = p.p.m. of turbidity and X = submergence in inches. The curve for the portable turbidimeter herein described is:

$$\log y = -1.35652 \log \times + 3.2085$$

The shortcomings of the portable turbidimeter are appreciated. The turbidity increases at lower levels of the basin so that the readings obtained may not describe the nature of the actual effluent and yet be indicative of plant operation. At Indianapolis, however, the information obtained through the use of the portable immersion turbidimeter has been very helpful in connection with plant operation.

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Canadian Section of A. W. W. A. Met March 22-24 at Ottawa

A. U. Sanderson—Elected Chairman

A. U. Sanderson, Chairman-Elect

More than 350 Canadian water works men attended the 13th Annual Convention of the Canadian Section of the American Water Works Association which was held in Ottawa at the Chateau Laurier on March 22nd-24th.

Ross L. Dobbin, General Manager, Public Utilities Commission of Peterboro opened the symposium on "Methods of Charging for Domestic Water" which was a feature of the meeting. The "Flat Rate" was discussed by G. G. Routledge, Supt. Water Distribution, Toronto, and W. L. McFaul, City Engineer of Hamilton. "The Meter Rate" was discussed by T. H. Hooper, Superintendent Water Works, Winnipeg, and G. C. Storey, Manager, Water Commission, Windsor. It was developed that there are now 69 one hundred percent metered water systems in Canada. There are 559 water works plants in Canada with a total of 1,483,670 services, but only about 20 per cent of these are metered.

A symposium on Filter Plant Operation was opened by N. J. Howard and an innovation on the program was a paper by J. O. Meadows, Chemical Engineer of Montreal on the "Treatment of Waters for Industrial Use."

Western members voted to retain their membership in the Canadian Section rather than join the Minnesota Section as had been under consideration.

A. E. Berry, Secretary, reported that there had been no loss of members during the past year.

Chairman—A. U. Sanderson, Asst. Electrical and Mechanical Engineer, Toronto Department of Public Works.

New Trustees—F. P. Adams, City Engineer, Brantford, Ont.; Theo. J. Lafreniere, Chief Engineer, Provincial Department of Public Health, Quebec.

Immediate Past Chairman—W. E. MacDonald, of Ottawa.

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Honor to Honor Due!

Malcolm Pirnie Named President Elect Of the A. W. W. A.

Malcolm Pirnie, Pres.-Elect of the A.W.W.A.; Pres. Metropolitan Section A. S. C. E., Mayor-Elect, Scarsdale, N. Y.

The selection of Malcolm Pirnie as the next president of the American Water Works Association gives honor to whom honor is due. This honor comes on the heels of his recent election to the mayorship of Scarsdale, N. Y., and he in addition is president of the Metropolitan Section of the American Society of Civil Engineers.

Malcolm Pirnie has been a wheel-horse in the American Water Works Association for many years—devoting much of his energies and time to its work. Being chairman of its important committee on Water Works Practice is in itself an undertaking, but in addition he has found additional time to devote to its other interests and activities. In behalf of the Association and the A. S. C. E., Mr. Pirnie has spent considerable time in Washington fighting for recognition of water works betterments as a measure of unemployment relief and in getting through favorable legislation.

Congratulations, Malcolm. It is a case of honor to whom honor is due.

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Association Meetings Scheduled

April 17-19—Arizona Public Health Association. Hotel Santa Rita, Tucson, Ariz. Secretary, Jane H. Rider, care of State Dept. of Health, Tucson, Ariz.

April 19-20—Illinois Section of A. W. W. A. Hotel Nelson, Rockford, Ill. J. J. Doland, Secretary, University of Illinois, Urbana, Ill.

April 21-22—Montana Section, A. W. W. A., to be held at Harve, Mont. Herbert B. Foote, Secretary, Director, Division of Water and Sewage, State Board of Health, Helena, Mont. In connection with the above, there will be held a two-day short course for water works operators, April 19th and 20th.

April 23-28—Oklahoma Water and Sewage Conference. A. & M. College, Stillwater, Okla. H. J. Darcey, Secretary, Chief Engineer, State Health Department, Oklahoma City, Okla.

April 26—New England Water Works Association. New Britain, Conn. Secretary, Frank Gifford, Tremont Temple, Boston, Mass.

April 27-28—Four States Section, A. W. W. A. Washington, D. C. (hotel not yet selected). C. H. Becker, Secretary-Treasurer, 400 Chestnut street, Philadelphia, Pa.

May 1—New England Sewage Works Association. Hotel Blackstone, Woonsocket, R. I. F. W. Gilcreas, Secretary-Treasurer, care of Weston & Sampson, 14 Beacon street, Boston, Mass.

May 4-5—Maryland-Delaware Water and Sewerage Association. Baltimore, Md. A. W. Blohm, Secretary, State Dept. of Health, 2411 N. Charles St., Baltimore, Md.

May 11-13—Pacific Northwest Section, A. W. W. A., to be held at Bellingham, Wash. Ernest C. Willard, Secretary.

EDITORIALS

Licensing Operators

SINCE April, 1926, there has been on the Statute books of New Jersey a law known as the New Jersey Licensing Act. This Act requires that operators of water purification and sewage treatment plants prove that they are qualified to take responsible charge of such plants. The licensing of operators is in the hands of the Engineering Bureau of the State Department of Health —the license being granted only after the applicant has proven fitness upon oral or written examination, backed by experience and by general qualifications.

After six years of experience with the Licensing Act, constituting a test of its practicability, the State authorities have within the year modified old rules or added new rules covering the licensing of plant operators. Before the recent meeting of the New Jersey Sewage Works Association, J. B. Baty of the State Department of Health explained to its members the more important changes in these rules. He said, that the Department felt that the new rules were justified on the score that these would insure higher grade and better prepared plant operators than has been demanded heretofore. The new rules recognize eight main classifications of licenses, thereby, being more flexible than the old rules. Operating experiences and training have been given more weight than in the past and what seems a rather important addition to the rules is that which restricts the licensee to the operation of a particular plant.

This last stipulation appears to be one of high importance to operators in that it will probably prevent the displacement of operators, as a political expediency, and prove instrumental in keeping the water works and sewerage departments from becoming political foot-balls. That this is the intended effect, was seemingly apparent from remarks made by H. P. Croft, Chief Engineer of the Department of Health, before the Association in amplification of Mr. Baty's presentation. He said in substance, that efforts toward bettering the licensing situation had been put forth with a two fold purpose in view. The first was that of insuring more efficient operators and better plant operation. The other, to make it possible for the operator to think more about his work and less about his "job" and what would happen to it after each election.

The new licensing rules of the New Jersey Department should command the attention of other organizations—state or professional—that are now contemplating the drafting of laws pertaining to the licensing of operators of plants. After seven years, the idea of licensing operators and supervisors of plants in New Jersey seems to be increasing in favor—most particularly among the operators themselves. The idea is also spreading to other sections of the country—Texas and Ohio just now are seriously studying the matter, preparatory to framing legislation making licensing of operators compulsory.

As pointed out by Mr. Croft, in these times the Licensing Act has proven of particular value to operators in protecting them against the loss of their jobs. Men out of employment, who in normal times would not consider municipal employment attractive, are now seeking through every known channel, including political pressure, the positions of plant operators and perhaps would get the desired position except that someone at city hall suddenly discovers that they are forced to employ only licensed men. Thus it is that the license, once considered a hardship and a show of authority by the State Department, is now turning out to be an excellent policy against loss of positions by operators.

It was evident in the meeting of the New Jersey Sewage Works Association that the operator felt that the Licensing Act was one of the best things that had happened to improve his status and that the license was somewhat of a combination of professional certificate and job insurance policy—and further it might well be made to serve as a sort of union card. The union card idea may not appeal to licensed operators in the upper range of the eight classifications, but after all union cards do have a value.

Enough has been learned of licensing values to warrant the statement that every state should have a Licensing Act—and what is equally as important, should see that it is enforced. The New Jersey State Department of Health Engineering Bureau devotes 10 per cent of its time to this phase of supervision of water works and sewerage—what's more it finds that it has paid.

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Improving Convention Exhibits

RECENT announcement comes from Chairman Guy C. Northrop of the Special Exhibit Committee of the A. W. W. A., to the following effect.

At the Chicago Convention of the A. W. W. A.—June 12-16th, it is proposed to repeat, in substance, the exhibit contest that was held so successfully at the Memphis convention last year. The Executive Committee of the Association of Water Works Manufacturers, in sponsoring the Memphis contest, had in mind that it would improve the quality of the exhibits and would cause the members to take more interest in the displays than before. There is no question but that both of these objectives were accomplished and that is why it is to be repeated at Chicago.

Again this year there will be three prizes to winning exhibitors: First prize, second prize and third prize. In addition there will be three prizes to the active members who display the most intelligent interest in the exhibits, as disclosed in their votes as to which exhibit is considered the most instructive for one or another reason. Exhibits will be planned to attract attention and justify study by the visitor preparatory to the voting which will decide the three prize winners.

At Memphis the scheme was new, but even so the innovation brought many visitors to the booths for critical examination of the exhibit rather than with the thought of being entertained. This year the contest should attract an increased number of visitors to booths and the Water Works Manufacturers Association is to be commended for having started the exhibit contest scheme which is of mutual benefit to manufacturers and members.

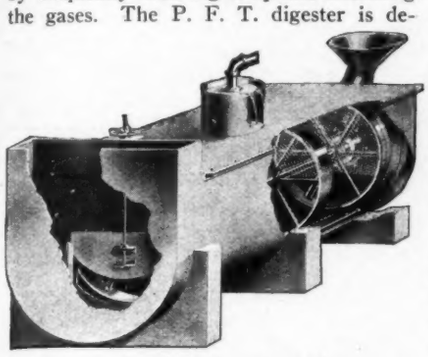
L. H. Enslow

NEW EQUIPMENT AND MATERIALS

A Screenings Digester Developed by P. F. T.

A new scheme of disposal of sewage screenings has recently been developed wherein the process of fermentation is employed, the residue from which is inoffensive and subject to drying on open beds, spreading on land, or incineration without odor nuisance. The Pacific Flush Tank Company of New York and Chicago have perfected a digester for use in this process which is described in their Bulletin No. 111.

Sewage screenings can apparently be successfully femented if the formation of the troublesome surface matter is prevented by frequently breaking it up and liberating the gases. The P. F. T. digester is designed to accomplish this by use of a perforated metal or wire mesh horizontal drum which is revolved and thus completely inverts the fermenting mass within the closed digester. The mass is thus kept thoroughly *mixed and wetted* and the gases are liberated. The units are constructed inexpensively of steel for the most part. The raw screenings may be continuously or intermittently introduced at one end and taken off in a stabilized condition at the other end in the same manner. A gas dome and seal are provided in the top of the digester. Heating coils within are provided to obtain the desired temperature such as is maintained in sludge digesters. The digester is a self contained unit and is equipped so that the digestion drum may be rotated at any practical speed, continuously or intermittently, and manually or automatically as desired.



The P. F. T. Screenings Digester

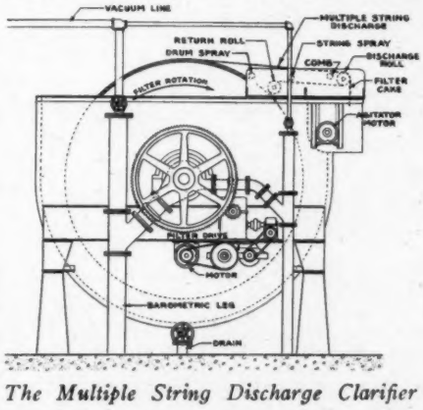
Pilot units of size have been in operation since June and November 1930. Giving the drum a few rotations twice daily with periodic feeding of the raw screenings has been sufficient to produce satisfactory operating efficiencies—screenings slowly working their way through without difficulty. More frequent rotations increase the fluidity of the mass.

The Pacific Flush Tank Company have issued a new bulletin (No. 111) describing the digester, and it contains additional information of interest pertaining to screenings and the disposal of such. Address, Pacific Flush Tank Company, 4241 Ravenswood Ave., Chicago, or 136 Liberty St., New York City, for a copy.

Wright Vacuum Filter for Sewage or Effluent Filtration

What is termed a "multiple string discharge clarifier" in the adaption of the Wright Vacuum Filter is now being offered by Municipal Sanitary Service Corporation. This equipment has been developed by them in cooperation with Arthur Wright and Associates. It functions very similarly to the Wright filters employed successfully for a number of years in paper mills for clarifying the "white water," with pulp recovery resulting. It contains many of the features of the Wright Sludge Filter—which also employs strings, arranged much like a multiple rope drive belt, for removal of the cake formed on the filter. The new filter has been especially designed or altered to handle high rates of liquid flow with small solids content such as settled sewages, effluents from sprinkling filters, activated sludge plants, chemical precipitation effluents and even crude sewages after screening. Its operation usually entails the use of a filter-aid of some sort—paper pulp or shredded waste paper produced on the grounds with or without coagulent addition, being among the best. The filter-aid is returned for reuse in the clarifying-filtration effect to produce a highly clarified effluent at minimum cost. The filter-aid finally saturated with sewage solids is disposed of along with the sludge to digesters and thence to vacuum filters or sand beds, or it may be directly incinerated.

Multiple string discharge clarifiers are now being installed at the Rockville Center Sewage Treatment plant to filter the activated sludge plant effluent.



The Multiple String Discharge Clarifier

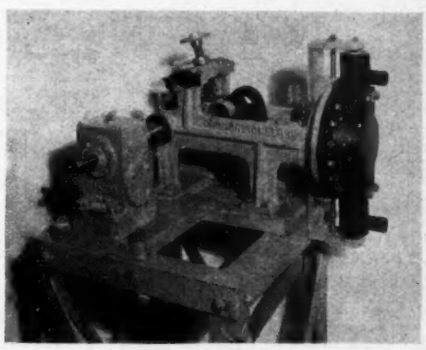
These filters are available in sizes from 0.5 to 5 M. G. D. capacities—the largest unit requiring but 5 H. P. for operation. The filter operation itself produces the required vacuum of 6 to 8 inches of mercury by use of barometric legs. The small ground space required for high capacity units is attractive as is the positiveness of action and results.

The manufacturers offer to install portable demonstration units as a means of evaluating results and setting up performance guarantees and costs—this without charge to the municipality or obligation to purchase.

For additional information address Municipal Sanitary Service Corporation, 155 East 44th St., New York City.

The "Ferr-O-Feeder" an Ingenious Device of Proportioneers

The "Ferr-O-Feeder" should be of particular interest at this time when ferric chloride and other chemicals are gaining importance in the sanitation and water treatment field. It was expressly designed to feed ferric chloride accurately without corrosion difficulties. The proportioning pump delivering the reagent and all other parts in contact with the chemical solution are constructed of rubber. The pump shown on the right side of the unit illustrated above is of the diaphraghm type. Specially constructed *live* rubber check valves, employing the ingenious Bunsen principle, are employed. They are positive closing even though a piece of trash should lodge in them. Demounting for inspection or cleaning is simple.



The Ferr-O-Feeder

The feed of chemical is varied by changing the length of stroke of the pump diaphragms—even to the minute adjustment of a micrometer screw—and without stopping any operation. Diaphragm heads of various sizes are available for ready interchange without disturbance of the remainder of the mechanism. By an ingenious arrangement of variation of length of stroke the accuracy of the reagent pump feed is positive and dependable for all settings.

The "Ferr-O-Feeder" has not the fluid motor for its power source such as the "Tret-O-Unit" has in its various adaptations for manual or automatic feeding of chemical, but it can be made to feed automatically by belt drive connected to the pumps delivering the material to be treated and is equipped with motor drive for manual control. At the Chicago Sewage Works the "Ferr-O-Feeder" automatically feeds ferric chloride to sludge by belt connection to the sludge pumps and thus maintains a very constant pH value in the conditioning operation.

In cases where it is desirable to control the rate of chloride feed directly from the sludge flow, independent of the sewage pump, the diaphragm type of "Tret-O-Unit" actuated by the sludge-operated "Roto-Flo" may be used. This latter method would eliminate any inaccuracy of feed due to varying overall efficiency of the sludge pump.

"Ferr-O-Feeder" may be obtained in a wide variety of sizes, with deliveries ranging from a maximum of 0.1 gallon to 8 gallons per minute. Interchangeability of various size reagent heads permits adaptation of these units to meet increased plant demands. Adjustment by minute degrees permits the operator to maintain a constant pH concentration at all times.

For bulletins describing the "Ferr-O-Feeder," the "Chlor-O-Feeder," the "Tret-O-Unit" and other chemical feed units produced by Proportioneers, address them at 737 No. Michigan Boulevard, Chicago, or write Builders' Iron Foundry at Providence, R. I—the latter being affiliated with Proportioneers.

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Farrel-Birmingham Company's Herringbone High Speed Gear Units for Speed Reduction or Speed Increasing

Standard industrial gear units are designed for use with electric motors running at a maximum speed of 1800 revolutions per minute. They are satisfactory for reducing speed but not for increasing speed.

When a gear unit is required for connection to a steam turbine or other purposes where the speed of the pinion shaft exceeds 1800 revolutions per minute the problem in the past has been considered as a special one. Now, however, W. E. Sykes, Chief Engineer of the Farrel-Birmingham Company of Buffalo, N. Y., has developed and standardized a series of gear units suitable for speeds up to 8500 r.p.m. and powers from 120 h.p. to 2,500 h.p., with ratios as great as 12 to 1 for increasing or reducing speeds.

This new series of gear units is especially adapted to serve as speed increasers for connecting Diesel engines, gas engines or other prime movers operating at speeds of 225 to 600 r.p.m. to drive centrifugal pumps, operating at speeds from 1200 to 3600 r.p.m.

Gear drives in the past have been occasionally troublesome but during the past two years the improved technique of gear manufacture and the better understanding of the characteristics of speed changing gears has made it possible to produce completely satisfactory units.

Precision in gear cutting has made it possible to utilize the efficient herringbone style pinions and wheels in developing the new Farrell-Sykes speed changers. The proportion of the gears as regard to the number of teeth, pitch, face, face widths, etc., are chosen on a scientific basis, special consideration as to whether gears are to be used for increasing or decreasing speed being given. Each pinion and wheel is made of alloy steel and heat treated to the proper hardness. The teeth are lapping pinions resulting in a mirror-like finish on the bearing surfaces of the teeth.

It now being well known, that high speed gear units cannot have a high mechanical efficiency if the gears are allowed to run in a bath of oil, the new Farrell-Sykes unit is provided with forced lubrication (7 to 15 lbs./sq. in.) of all bearings and spray lubrication for the gear teeth. Axial float of the gears is not necessary when precision in manufacture precludes inaccuracies. Consequently axial float has been eliminated and thrust collars provided.

Rigid gear housing is essential and has been provided in the new unit as noted in the illustration. Durability and rigidity of shafts is insured by the liberal diameters which also minimizes vibration and noise. The new units are of correct size to transmit the rated load 24 hours each day for 5 years without appreciable wear. The gears are liberally designed and will carry from 2 to 3 times the rated load for periods up to one hour without showing serious signs of wear—representing a high factor of safety to take care of possible overloads and possible defective lubrication.

The mechanical efficiency of the new gear units is from 98.3 to 98.9% when used for reducing speeds and from 96 to 98% when used for increasing speeds.

For more detailed information covering this improved gear unit write the Farrel-Birmingham Company at Ansonia, Conn., or Buffalo, N. Y., for descriptive literature.

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Novel Adaptation of Mercoid Pump Cut-out Switch

A check valve equipped with a mercoid flow switch has just been introduced by Barrett, Haentjens & Co., Hazleton, Pa. This new switch fitted valve is designated as the type "M" check valve, and fills a long felt need for the flow switch feature.

The purpose of the switch is to shut down the pump in the event that it loses its water during operation. The switch is connected into the low-voltage coil of the motor starter, and is actuated by the valve flap. When the pump is in operation and delivering water, the flow through the valve raises the flap and closes the switch. When the pump loses its water the flap falls, the switch opens, and stops the pump.

Check Valve Showing Position of Mercoid Automatic Pump Cutout Switch

The switch can be arranged for either horizontal or vertical mounting of the valve. Literature available upon request to Barrett, Haentjens & Co., Hazleton, Pa.

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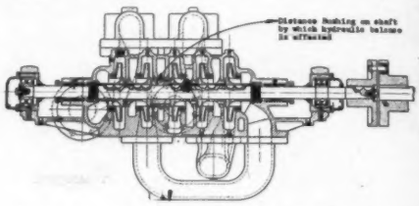
A Novel Development in Pump Design

The Pennsylvania Pump & Compressor Co. has developed an ingenious method of maintaining hydraulic balance in its multi-stage centrifugal pumps. The impellers of these pumps are arranged so that the suction inlets are opposed to each other. Where the number of stages is even, as in a 4-stage pump, half of the impeller inlets face left hand, half right hand. In a 3-stage pump, the suction inlet of one



Sectional View of Class "OMSB" Five-Stage Centrifugal Pump

impeller faces left hand, the other two right hand. In a 5-stage pump, two of the impellers have the suction inlets facing the left hand, the other three right hand. In all pumps, at about the center line of the pump, two impellers are directly opposed to each other.

The Pennsylvania method of balance is accomplished by placing a properly proportioned distance bushing between the two directly opposed impellers, the diameter of this bushing being of such value as to put the rotating element in complete hydraulic balance. In this manner positive hydraulic balance is effected over practically the entire range of the capacity head regardless of the number of stages or whether the stages employ an even or odd number of impellers.

Notwithstanding the fact that the pump is in hydraulic balance, a ball thrust bearing is incorporated in the outboard bearing to take care of unusual conditions such as the introduction of foreign material and also to insure the proper alignment of rotating parts.

. This method of hydraulic balance has several advantages over other devices used to secure balance. For further details or information, address the Pennsylvania Pump & Compressor Co., at Easton, Pa.

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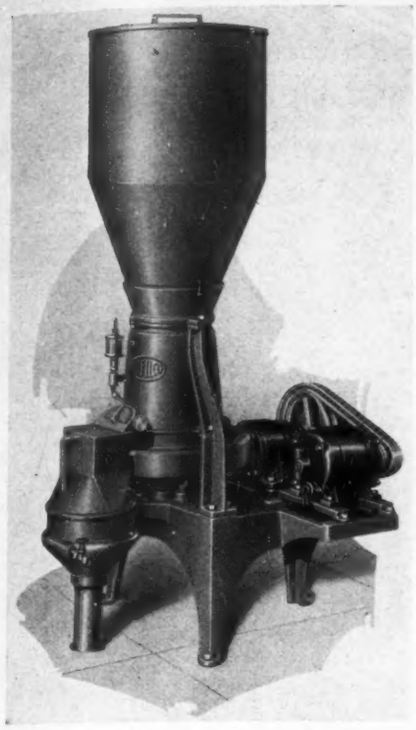
New Infilco Dry Feeder

The International Filter Company have just issued Bulletin 95 describing their newest addition to the line of "INFILCO" Dry Feeders. This feeder (No. 8) employs the positive feed principle using a knife fitted in a stationary ring to cut off a section of the revolving cylinder of



The New "Infilco" Dry Feeder No. 8

chemical emerging from the cylinder and supported on a revolving table.

The new feeder is designed to feed very small quantities of chemical with extreme accuracy—or it can be set to feed substantial amounts if so desired. It is practically dust tight and the Vortex-Mixer supplied with it assures thorough and prompt wetting of such materials as the powdered carbons and other chemicals that tend to float. It also draws dust down into the discharge through the suction created by the vortex effect, thereby increasing the cleanliness of the operation. Powdered carbon can be fed at any rate between 1 ounce and 50 lbs. per hour; hydrated lime—from 2 ounces to 100 lbs. per hour; alum—from 8 ounces to 150 lbs. per hour.

Write International Filter Company, 59 East Van Buren St., Chicago, Ill., for Bulletin No. 95.

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The Dorrco Sewage Distributor

A new, self-propelled, revolving sewage distributor, requiring hydraulic heads as low as 12 inches, is being manufactured by The Dorr Company. The American manufacture follows a practice well established abroad, where for many years sanitary engineers have recognized that the revolving type of distributor more fully utilizes the bed area, is less odor producing, requires less head and gives better performance than fixed spray nozzles.

The Dorrco Distributor consists of four chief parts: a stationary central column and base supporting the revolving mechanism; a rotating central column and manfold, concentric with and supported from the stationary column; a set of either two or four distributing arms, extending radially outward from the rotating column. A series of *adjustable* spray nozzles, extending along each distributing arm, apply the sewage evenly over the bed in thin, transparent *sheets* rather than as jets. The revolving column is supported by a cap which is carried by a single combination radial-thrust, self-aligning, roller bearing, mounted on the top of a stationary central column. The radial distributing arms are supported by steel cables shown in the illustration.

The distinctive feature of the Dorrco Distributor, which is said to contribute more to its efficacy than any other single item, is the adjustable flat spray nozzle. From it the sewage issues as a thin fan-like transparent sheet. Due to their staggered positions on the rotating distributing arms, the sprays wet overlapping areas, assuring the complete utilization of the surface of the bed at each revolution. The total absence of partially wetted spots on the bed surface also effectively discourages the breeding of flies, because the filter fly does not breed on continuously-wetted surfaces. The nozzles are readily adjusted in the field, both as to volume of sewage passed and as to the shape and thickness of the spray. Volume adjustment is secured by rotating the nozzle on the arm, thus blanking off a portion of the orifice milled in the arm itself. Shape adjustment is had by bending the flexible lip of the nozzle. Nozzle clogging is minimized by using a few large milled slots in place of a larger number of small holes and by leaving both ends of the nozzle lip open so that the simple sweep of a stick or screw driver will remove any obstruction which happens to lodge between the nozzle casting and its flexible adjustable lip.

The rotating distributor is available in a wide range of sizes. The largest designed to date having a diameter of 180 feet and capable of serving a contributing population of about 11,000 persons. The distributor may be fed from an automatic dosing siphon or directly by a pump and in either case satisfactory operation may be secured with a head of 12 inches of water. The discharge through the nozzles provides all of the tangential force required to rotate the arms even though wind is blowing.

Several Dorrco Distributors have already been placed in operation at American plants and additional information will be gladly supplied by The Dorr Company, Inc., 247 Park Ave., New York City.

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WITH THE MANUFACTURERS

Oxweld Welding Rods Published by the Linde Air Products Company

This 16 page booklet has been prepared for the purpose of setting forth in non-technical terms facts regarding oxy-acetylene welding practice employing welding rods of various composition. In the early days of oxy-acetylene welding and cutting, methods and apparatus were extremely crude compared to the skillfully designed and highly efficient equipment of today.

There is a welding rod for every purpose; there are several steel rods, several bronze rods, several aluminum rods. This booklet was written in order that the user may know exactly what rod will give successful results for his particular work.

This rod booklet is one which should be of great value to anyone doing welding work. It gives a complete and comprehensive view of welding rods, their uses, and their various advantages. Write to the Linde Air Products Company, 30 East 42nd St., New York City, for a free copy.

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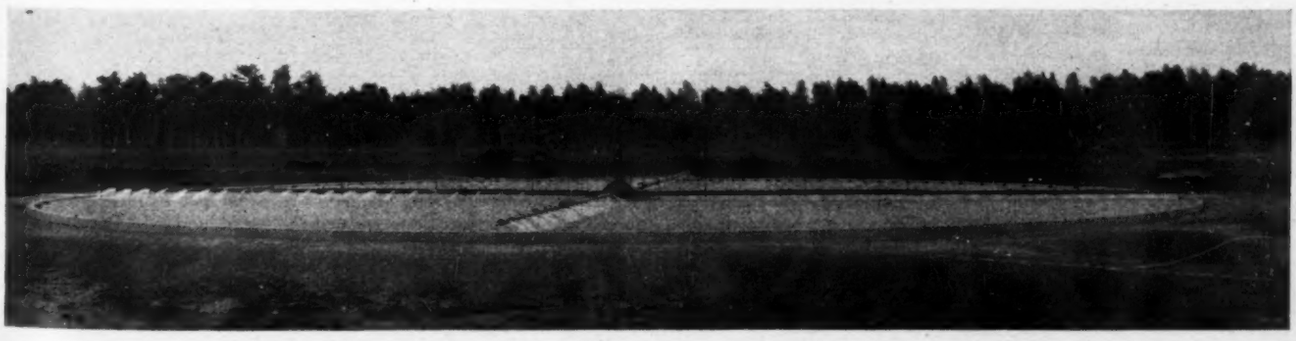
Water Meter Institute Issues Booklet on Metering

"The Business Basis of Metered Water" is a recently prepared 48 page booklet containing concrete data pertaining to metering of water. Opinions of authorities concerning the value of metering, supported by data covering the per capita consumption and water works economies as disclosed by actual case histories of metering, is presented. A copy of this informative publication may be had without charge by addressing The Water Meter Institute at 1427 Eye St., Washington, D. C.



Sprinkling Filter, Escanaba, Mich. The Dorrco Distribution in Operation Is 150 *Ft. Wide. Note Fan-like Sheet Sprays from Nozzles.*

Link-Belt Co.'s Diorama of a Sewage Treatment Plant to Be Exhibited at Chicago Exposition

When the Century of Progress Exposition opens in Chicago in June, visitors will have the opportunity of seeing, as a part of the display by Link-Belt Company of Philadelphia, a diorama depicting an idealized Link-Belt equipped Sewage Treatment Plant.

In the above illustration this diorama is shown in the making. Alfred A. Besel, the artist conceiving and supervising the

Diorama of Sewage Treatment Plant for Century of Progress Exposition.

work, and Albin Frohne, model maker, who frequently finds it necessary to use a magnifying glass in working on the more minute parts, are the two men in the picture.

Each diorama will be a combination of an oil-painting background, and a miniature model in the foreground, reproduced true to the major mechanical details of the actual machine portrayed. The model and painting form a blended unit which is neither picture nor model, but both.

The diorama will be exhibited in the General Exhibits Building.

Artist and Model Maker at Work on a

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New Literature Issued by Municipal Sanitary Service

Municipal Sanitary Service Corporation of New York has recently issued the following new pamphlets descriptive of equipment manufactured by them:

*Wright Vacuum Filter for Sewage Filtration (multiple string clarifier).

*Schofield Combination Bar and Fine Screens—Automatic and Self Clarifying.

String Discharge Vacuum Filter for Sewage Sludge.

M. S. S. Disc (fine) Screen for Sewage (R. Wurl Type).

M. S. S. Pneumatic Ejector System for Screenings, etc.

Decarie Screenings Incinerator—Water Jacketed Type.

(*Recently developed equipment.)

Copies of any or all of these pamphlets are offered gratis by the Municipal Sanitary Service Corporation, at 155 East 44th street, New York City, or may be had by addressing WATER WORKS AND SEWERAGE.

W. H. Wendler of Dallas Dies in his Sixth Year of Service with Leadite Company

Mr. Walter Hugh Wendler, Southwestern representative for The Leadite Company, died March 27th at the age of 30.

Mr. Wendler had been connected with The Leadite Company for six years and prior to this connection he had been on the engineering staff of the Texas State Board of Health.

Mr. Wendler was a member of The American Society of Civil Engineers, The American Water Works Association and was widely known and liked in the territory which he traveled for The Leadite Company. He leaves a widow, mother and 16 months old son.

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Activated Carbon the Modern Purifier

A new booklet, "Activated Carbon the Modern Purifier," has just been prepared for free distribution by Industrial Chemical Sales Company, makers of "NUCHAR"—the powdered active carbon which contains 92,500,000,000 particles of carbon in each gram. The new brochure covers the many uses of activated carbon

Front Cover of Booklet

in addition to the newer developments in its application to water purification.

Three reprints of recent mailing have also been received:

"The Activated Carbon Method of Water Treatment," by F. E. Stuart, is a review of the present status of the art of water treatment with powdered carbon.

"Experiences with Activated Carbon," by George R. Spalding, Supt. of Filtration, Hackensack Tester Co., who was the first to successfully apply powdered carbon in water treatment practice.

"Experiences with Powdered Carbon at Olean, N. Y.", by S. D. Poarch, Superintendent of Water Works at Olean, N. Y., who has found savings on chemicals result from its use.

These and other reprinted articles by water-works men, recounting the uses and value of powdered activated carbon, are available for the asking. Industrial Chemical Sales Company, New York Central Building, 230 Park avenue, New York, will be pleased to see that you get them.

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International Pipe Company Opens New Offices

International Pipe and Mining Company, Inc., of New York and San Francisco, announce that the name of the company has been changed to the Ipamco Pipe Corporation, with new offices in the Lincoln Building at 60 East 42nd street, New York. The San Francisco offices are in the Kohl Building at 406 Montgomery street.

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Arthur Wright and G. W. O'Keeffe Join Forces in New Organization

Arthur Wright and George W. O'Keeffe have formed an organization to be known as Arthur Wright & Associates, equipment and process engineers. Their main office is at 155 East 44th St., New York City, with a branch office at 1580 Macadam Road, Portland, Ore. Other offices are to be established throughout the United States and Canada.

They will act as general sales representatives for Filtration Engineers, Inc., Newark, N. J., and will aim to render an expert engineering service on all problems involving filtration in any of the process industries and the sanitary field.

Mr. Wright has been specializing on filtration problems for more than 20 years and is the author of a well-known treatise on the subject. Mr. O'Keeffe brings to the organization an experience of 15 years as an expert in drying and filtration problems. The aim of the new organization will be to adapt exactly the right machine to each particular industrial or sanitary engineering problem presented for solution.

Experience has shown that the proper functioning of process equipment is dependent upon the control of the material in process so as to enable the machine to maintain its economy and efficiency. In such work Messrs. Wright and O'Keeffe have played a big part in the successes established to date, and the new organization proposes to continue this particular branch of engineering with even greater intensity.

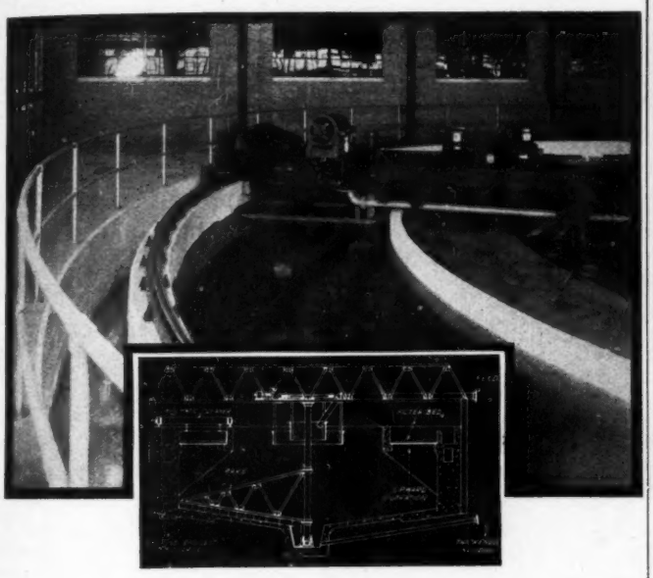
Burns & McDonnell Open Cincinnati Office

Burns & McDonnell, Engineering Company, of Kansas City and Los Angeles have opened an office at 612 Dixie Terminal Building, Cincinnati, Ohio. This office will be in general charge of C. F. Lambert, member of the firm, with H. J. Rosson as office manager.

FILTRATION EQUIPMENT CORPORATION

LAUGHLIN CLARIFYING TANK

For the Better Removal of Suspended Solids from Sewage and Industrial Wastes



—Permits of usual sedimentation and thickening operations within a tank, at high capacity for a given tank size.

—Removes solids by positive filtration.

—Filter bed embraces entire circumference of tank, extending inwardly five feet or more.

—Operated with a traveling magnet which cleans the filter bed as necessary.

—Tanks of round or rectangular type for any capacity.

—Low power and low operating cost.

FILTRATION EQUIPMENT CORPORATION
350 MADISON AVE. NEW YORK

"ISCO" Ferric Chloride

In the Filter Plant it is an effective and economical coagulant. **Ferric Chloride** works fast—requires less mixing and settling time.

In the Sewage Plant it is an aid to rapid sludge drying. Applied to crude sewage it will increase settling tank efficiencies and reduce loadings on sprinkling filters and other secondary units. **Ferric Chloride** treatment following sprinkling filters will produce a sparkling final effluent from humus tanks.

"ISCO" CHLORINATED LIME

For sterilization of water supplies or swimming pools, and for chlorination at sewage plants, provides a safe, convenient treatment with less total chlorine required.

"ISCO" SERVICE

"ISCO" now employs a full-time Sanitary Engineer-Chemist. May we give you further information backed by experience and service?

Write for full particulars.

INNIS, SPEIDEN & CO.
INCORPORATED
117 LIBERTY STREET, NEW YORK.
Established 1816

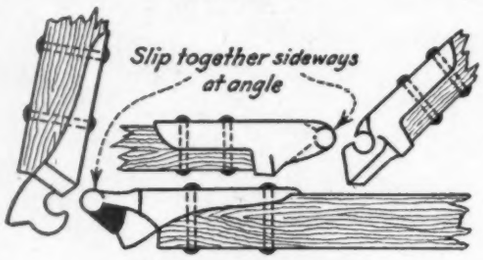
STEWART SEWER CLEANING MACHINE

Water Cleaning System, if you wish it, or Drag Bucket type.

WE WILL PAY FREIGHT AND CHARGE TO BILL.

We Ship Rods for Trial—who else will do this?

We also make a Rod that will float. Also rods with wheels for conduit work.



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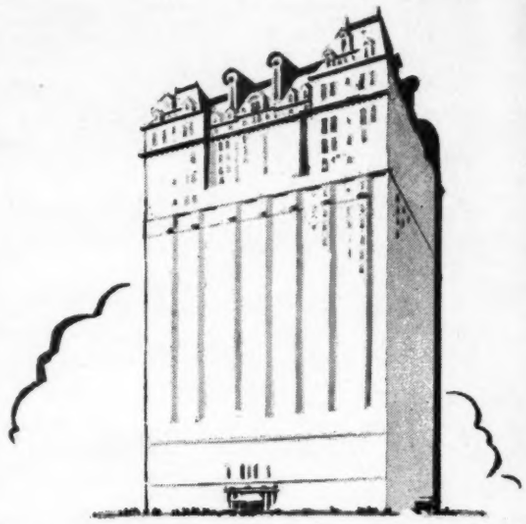

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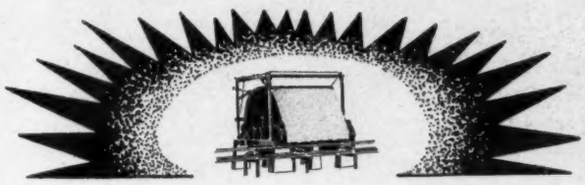

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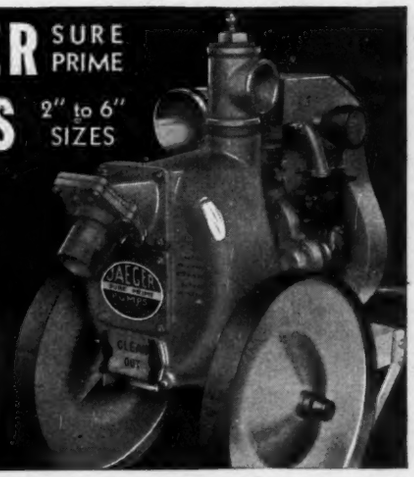

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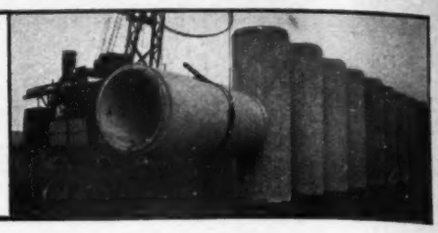

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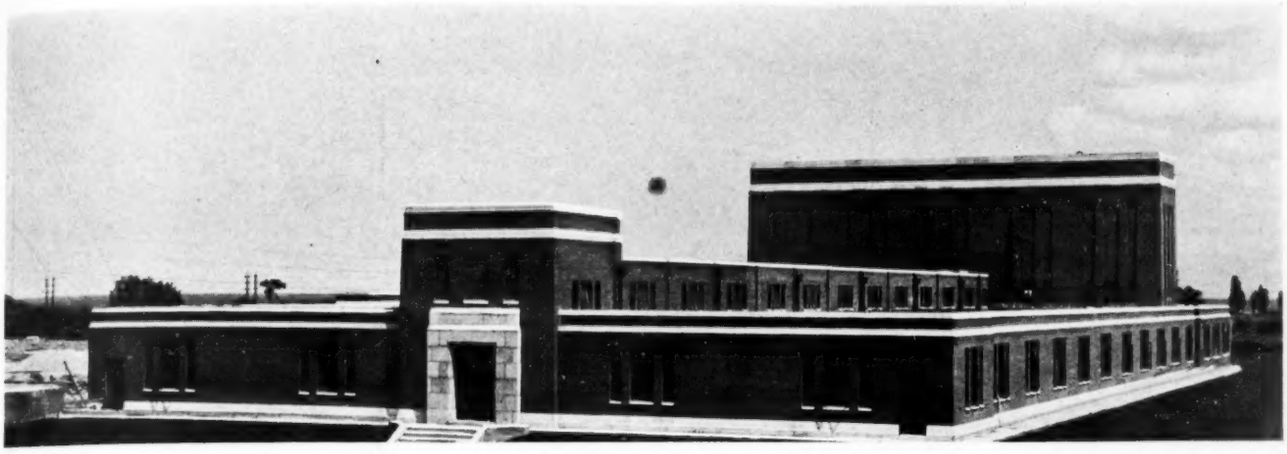

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